THE ENGINEER

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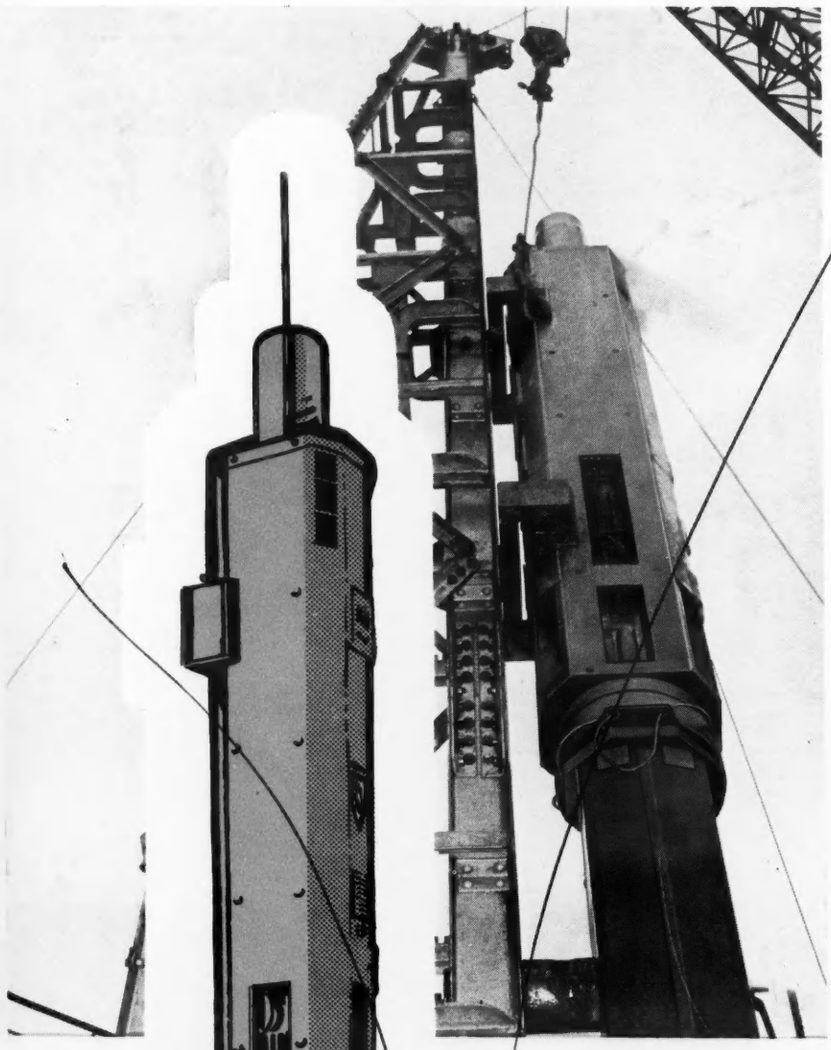

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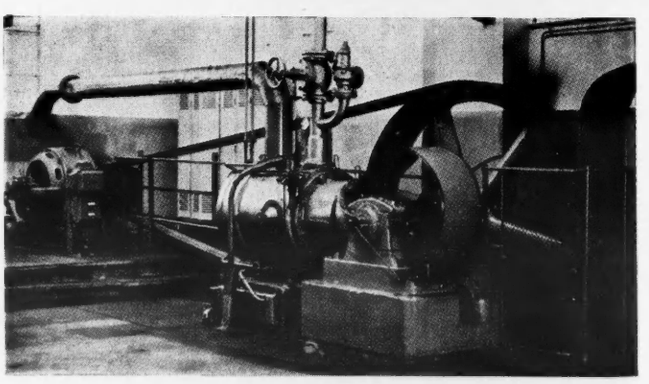

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Leaflet E1127 gives full details of the ER6 compressor. Write for a copy to your local Atlas Copco company or agent or to the address below.

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Established 1856

No. 5455 AUGUST 12, 1960 VOL. 210

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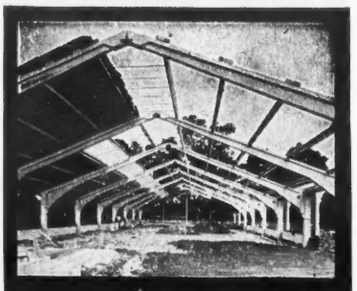

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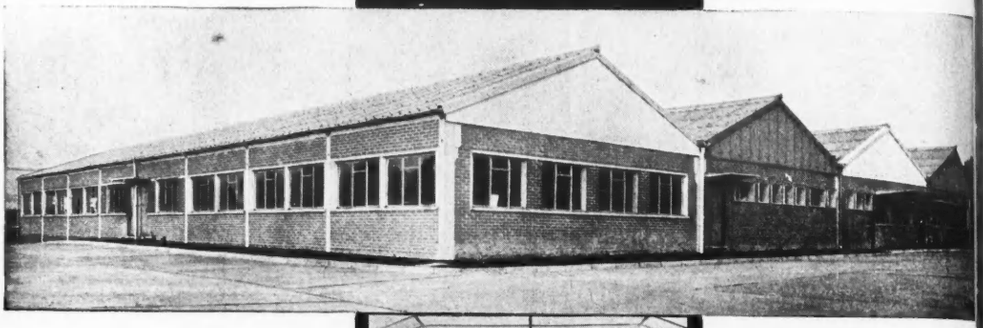

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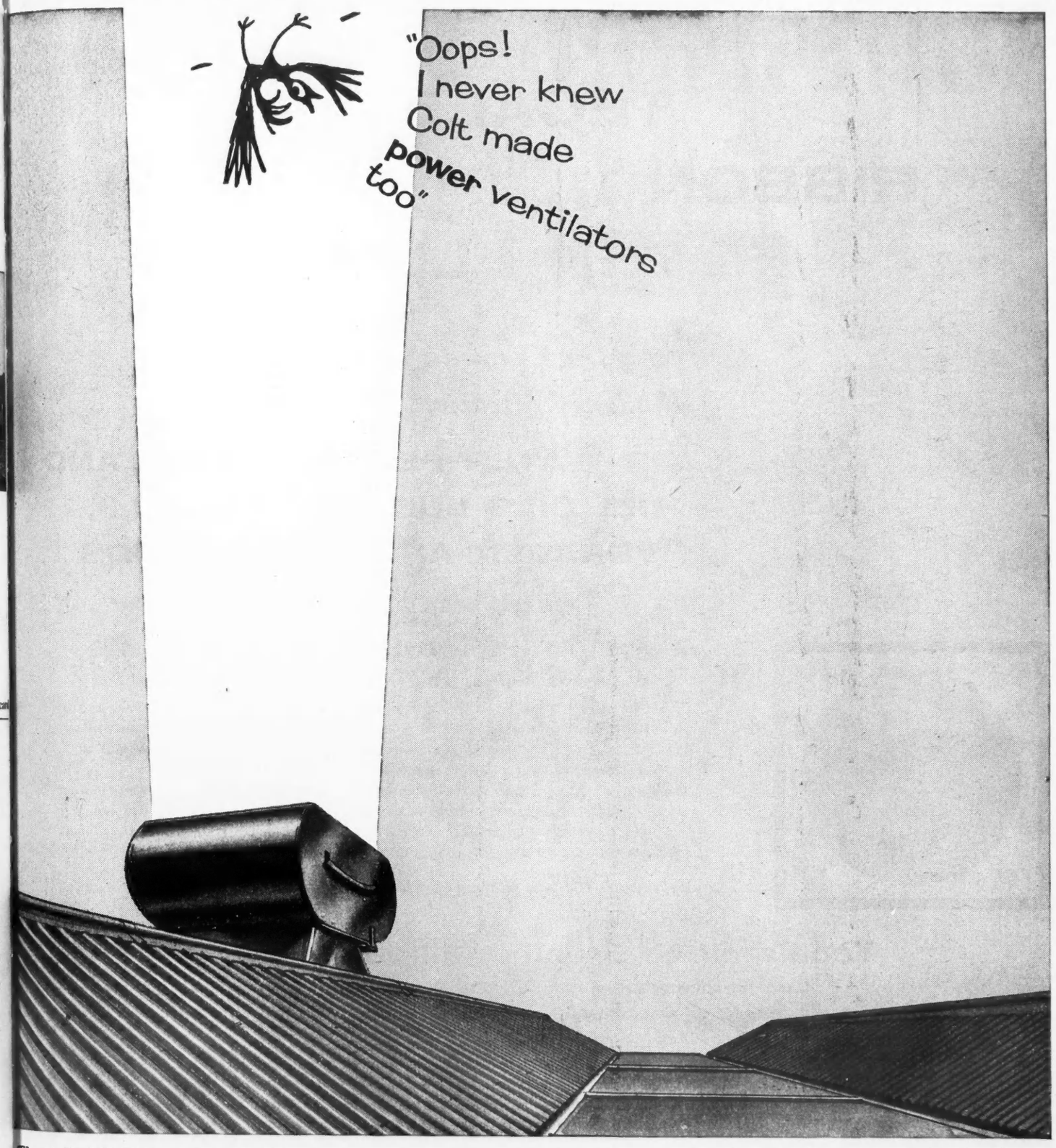

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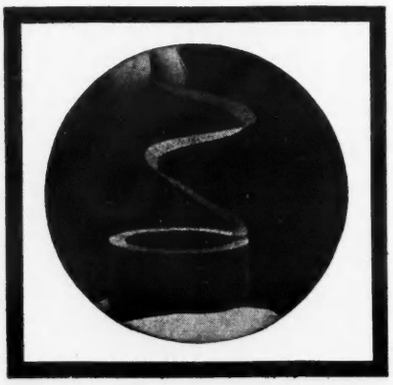

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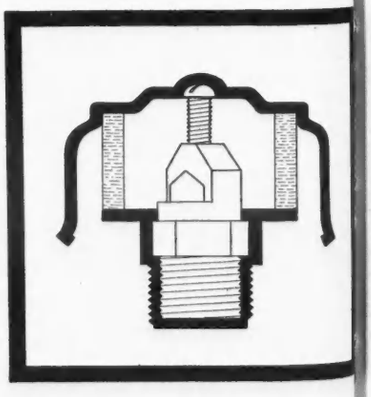

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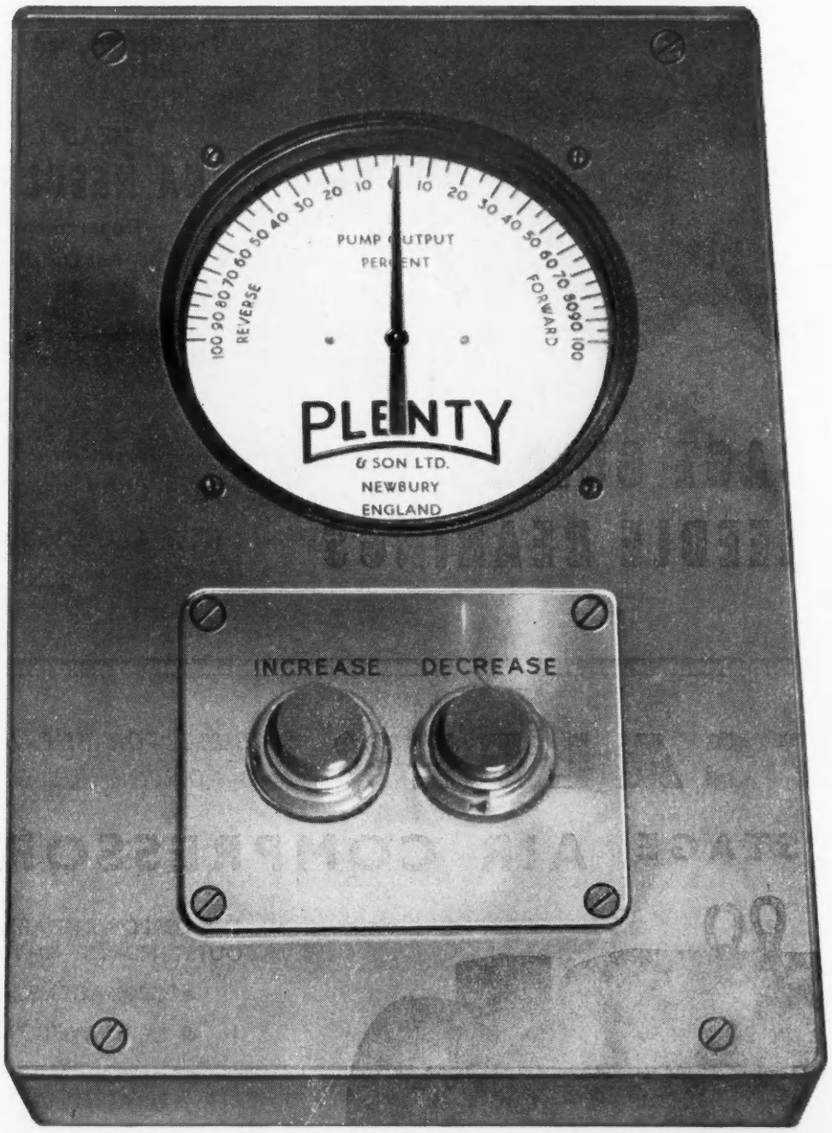

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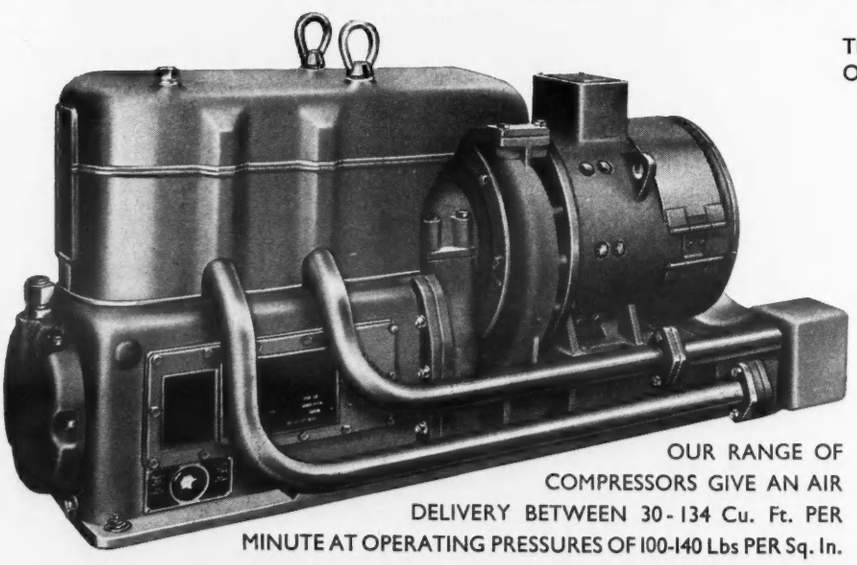

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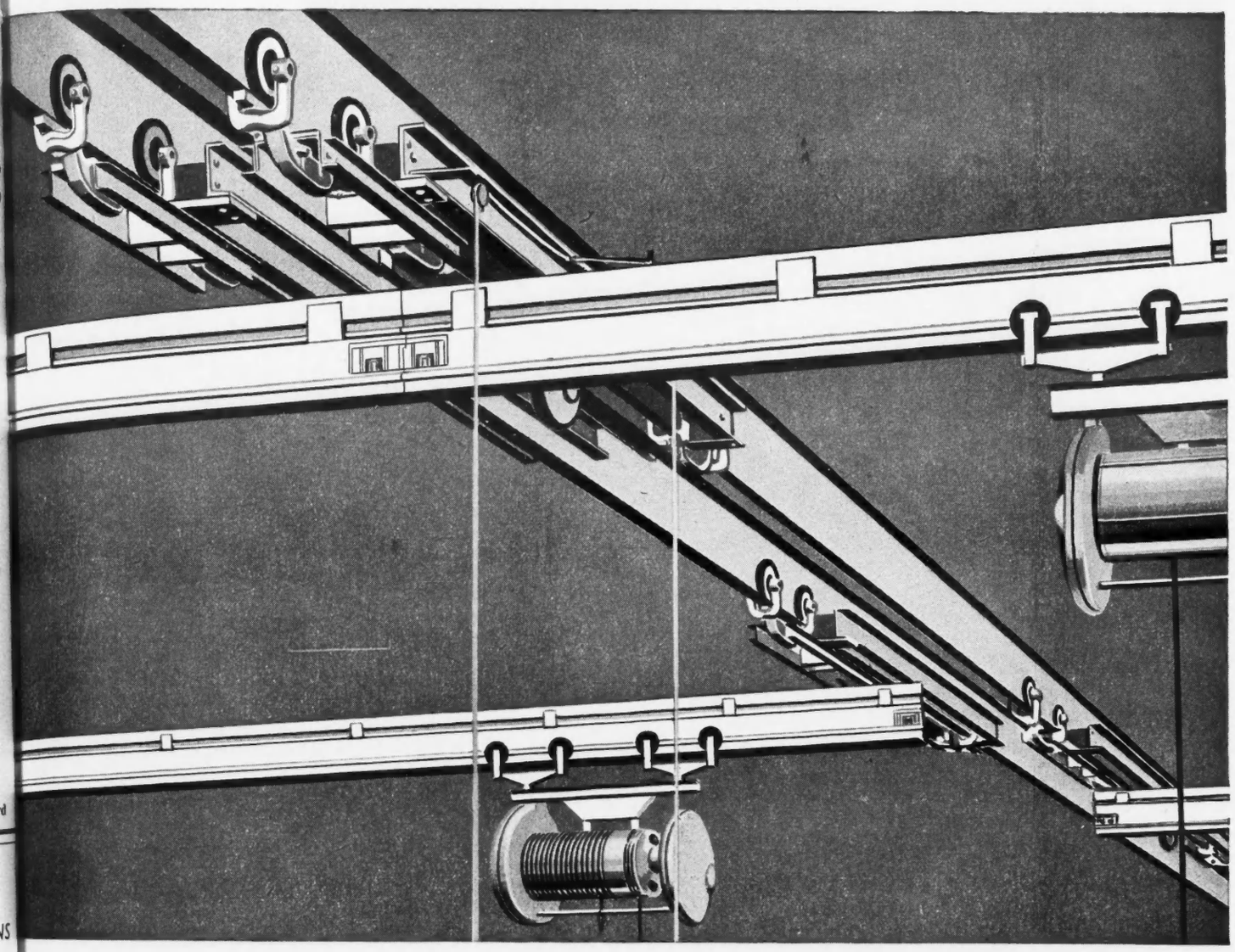

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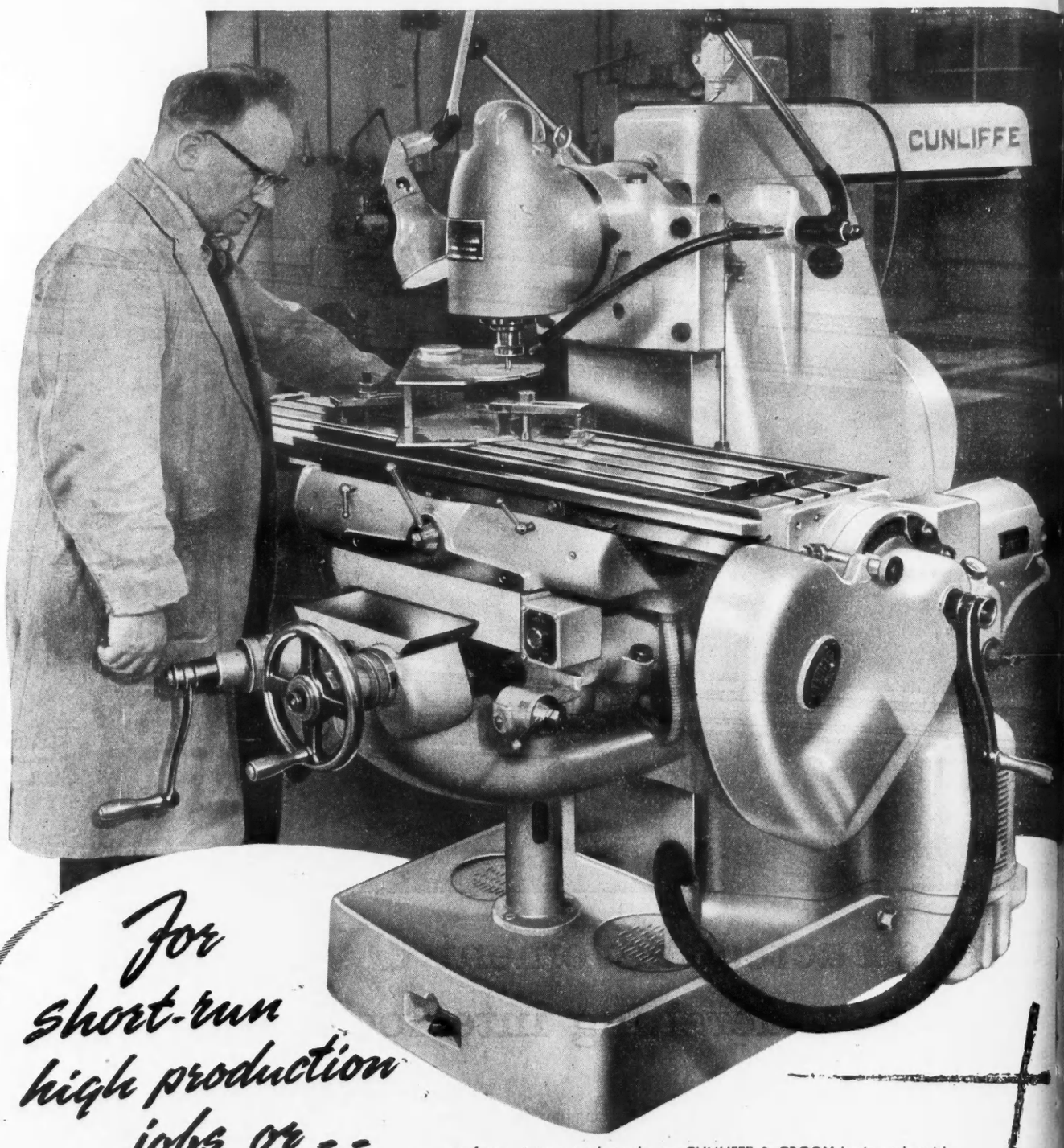

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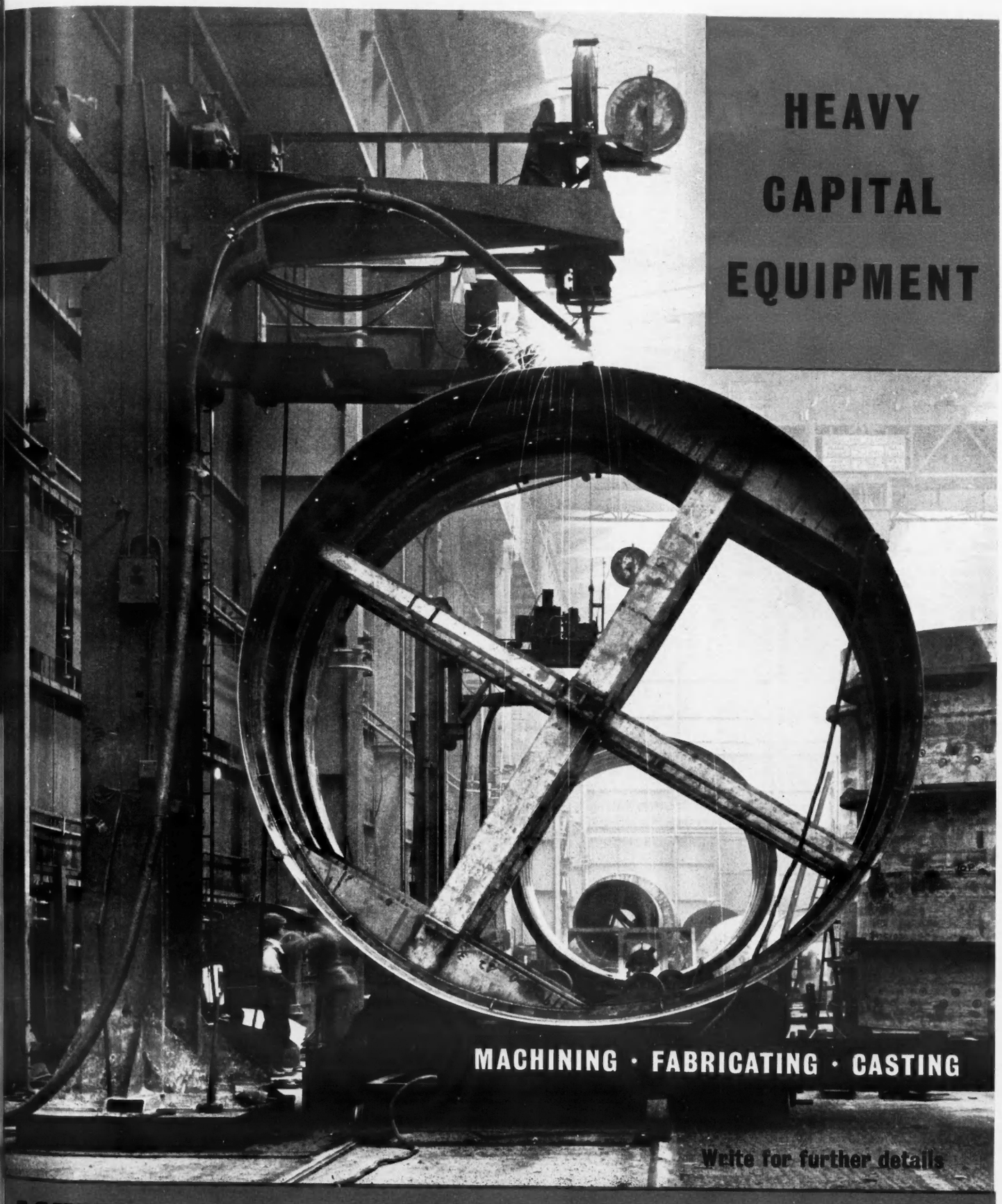

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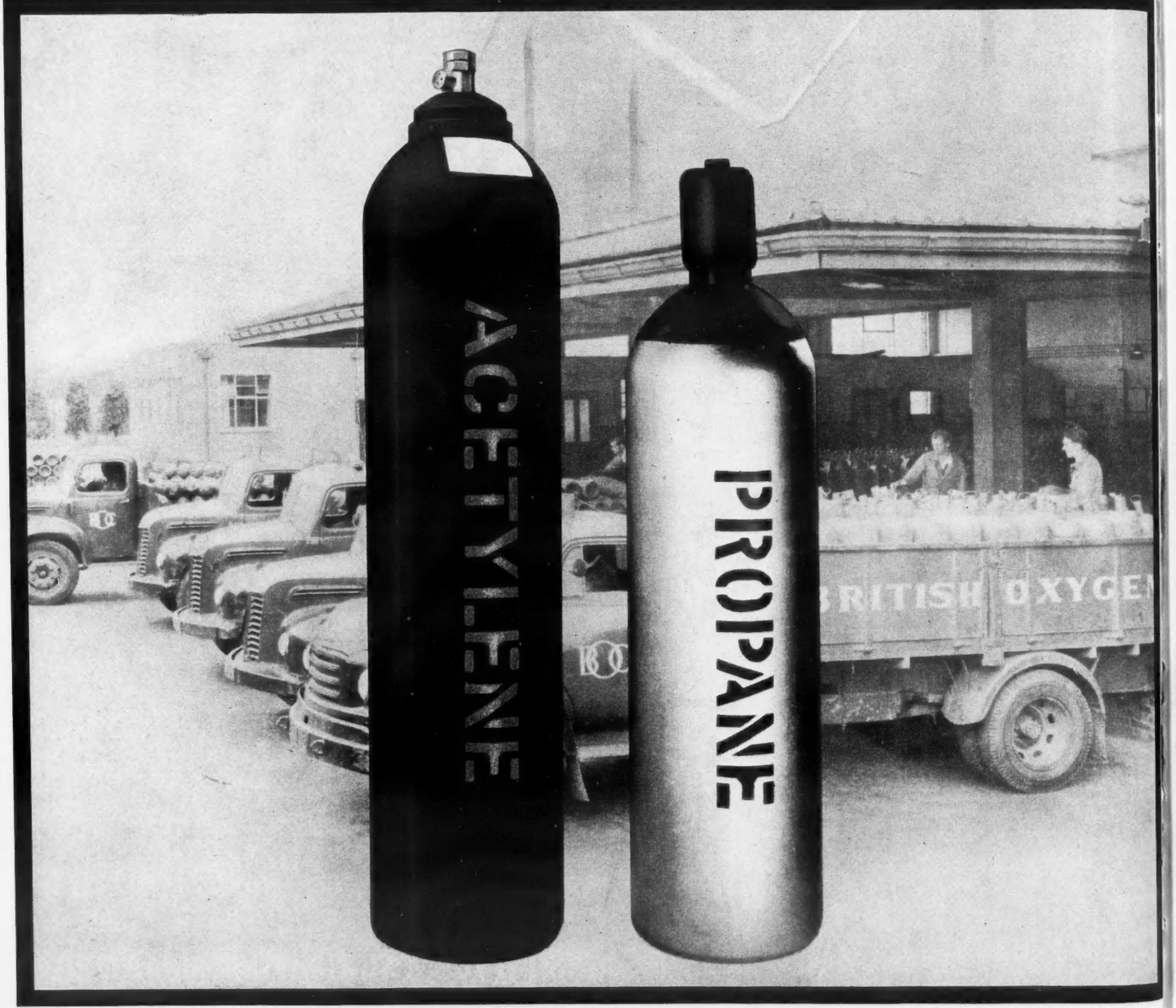

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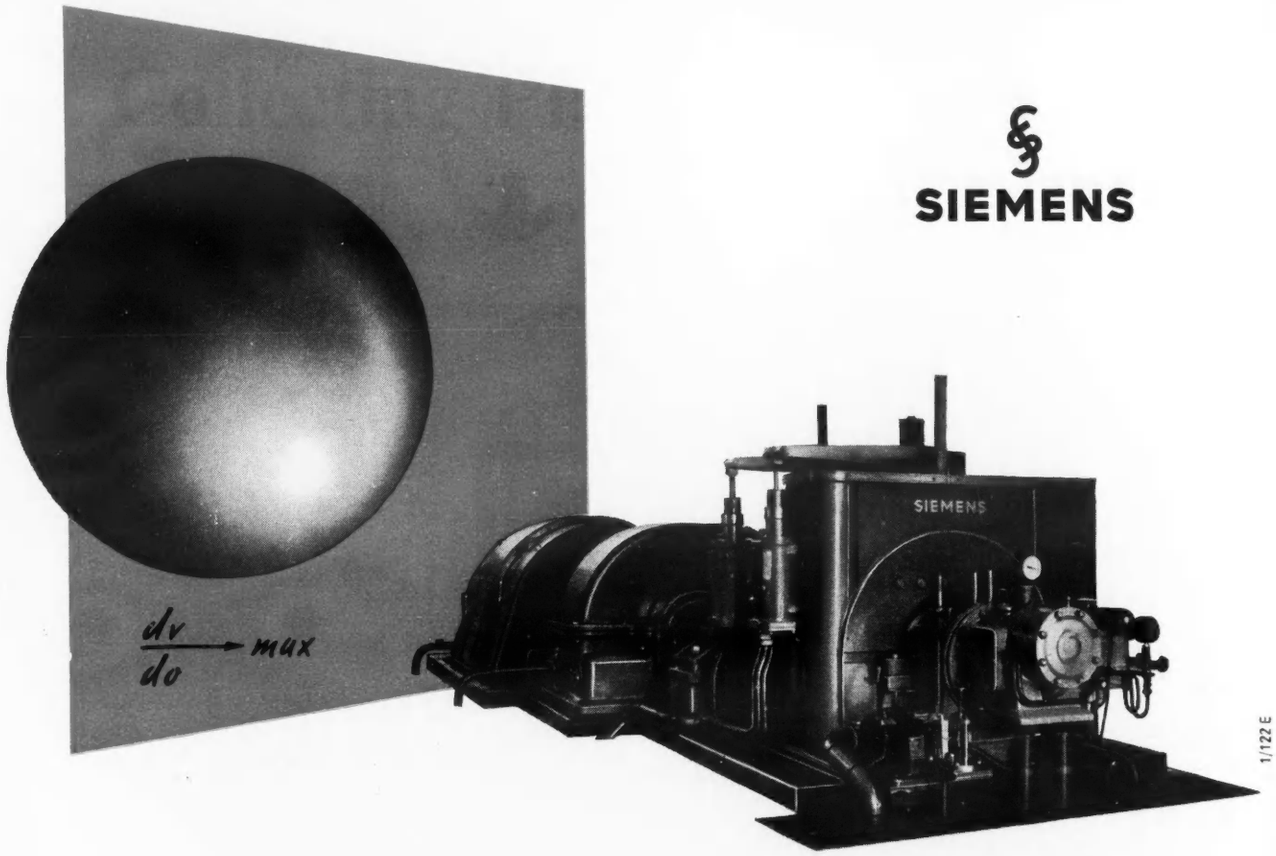

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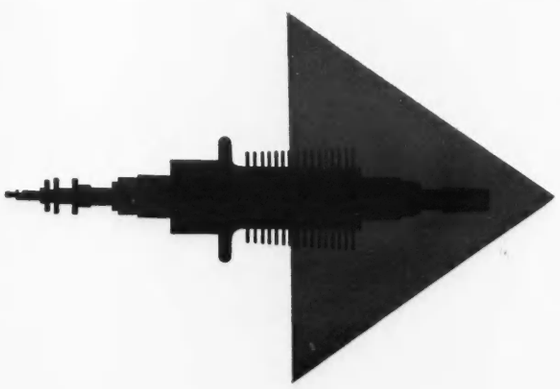

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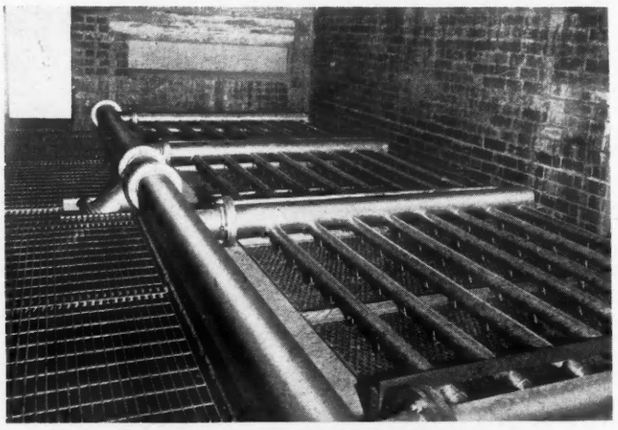
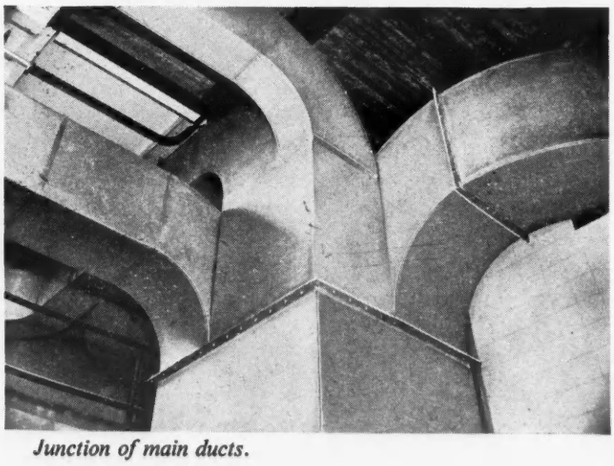
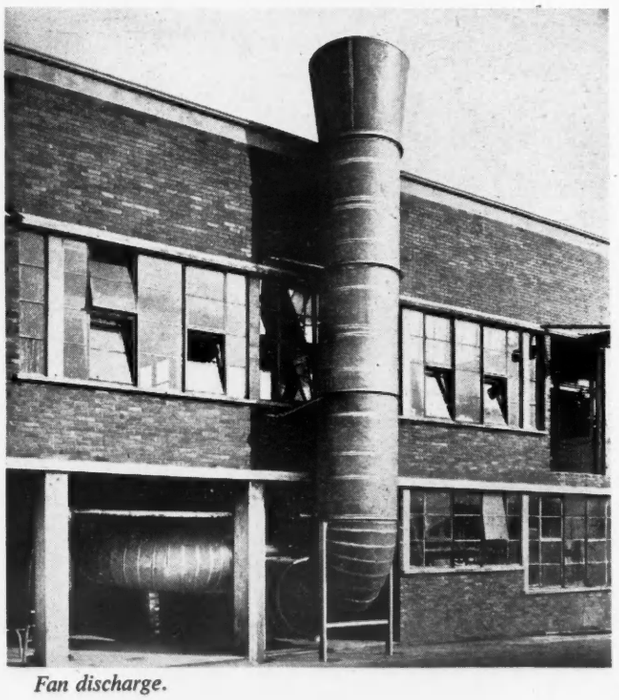
Tile presses showing duct connections.



Dust collector interior, Patent No. 810776.



Junction of main ducts.



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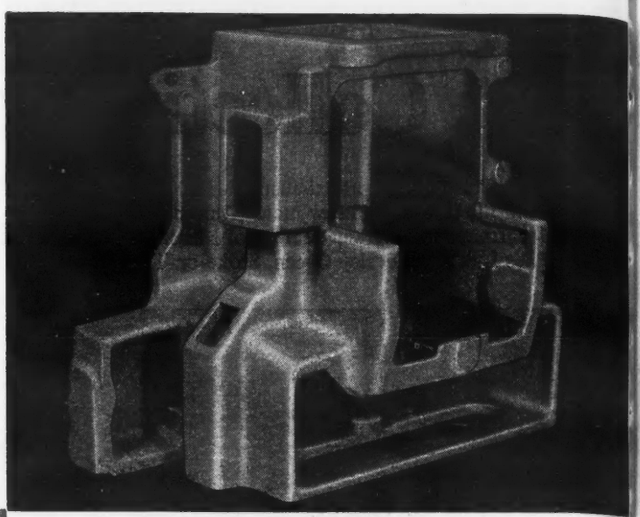

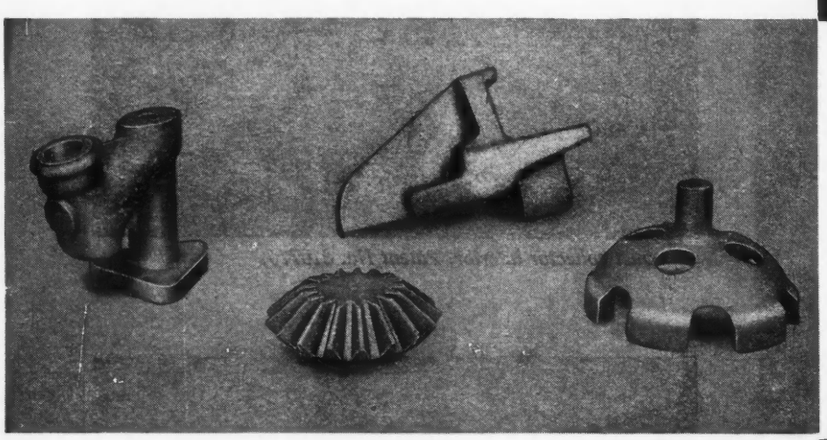

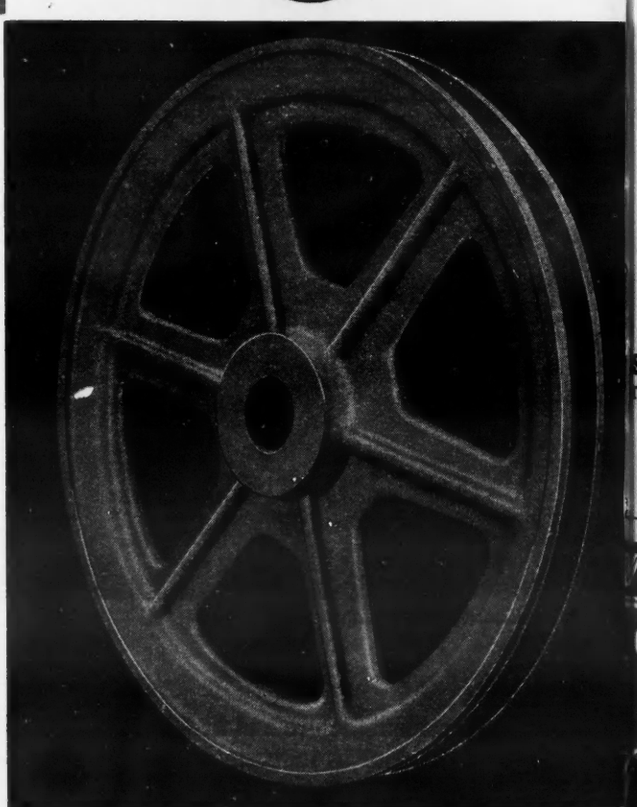

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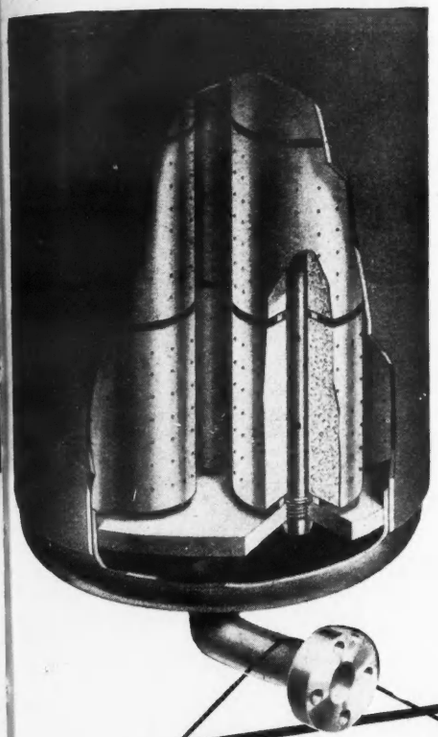
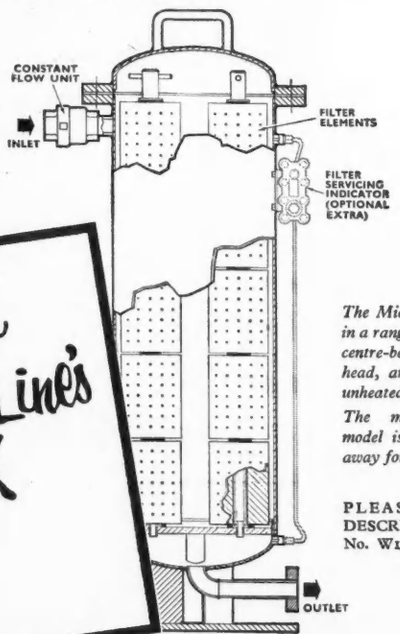


THE MICRO-PAK BY-PASS OIL FILTER for large stationary diesel engines, locos, marine engines, etc., has been developed by Stream-Line Filters Ltd. for use with detergent oils. (Where straight mineral oil is still employed the Stream-Line Edge Filter is the universally accepted filtration equipment).

This by-pass filter fulfils the vital function of removing ultra-fine peptised carbonaceous matter which tends to clog and impair the efficiency of the full-flow filter.

The life of the oil, engine, and full-flow filter element is considerably extended by the use of the Micro-Pak. It is economical, easily installed and easily serviced. The filtering element consists of low cost, expendable cartridges of lintless, acid resistant, cellulose material, giving the best filtration efficiency that can be associated with a sustained, adequate flow rate, together with high capacity for retained solids and, therefore, long cartridge life.



The Micro-Pak is available in a range of capacities, with centre-bolt or multi-bolt head, and either heated or unheated.

The multi-bolt unheated model is illustrated in cut-away form.

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Outlet for detergent oil cleaned by Stream-Line's new MICRO-PAK by-pass filter

CONVERSION KIT. Stream-Line can supply Conversion Kits for adapting existing 'P' Type filters to Micro-Pak operation. Please write for explanatory leaflet.

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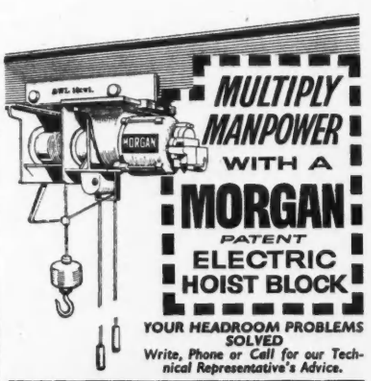

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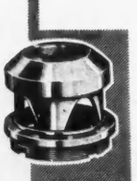
FOR ALL INDUSTRIAL PLANTS, THE ***VEE-REG*** VALVE PROVIDES AN ADVANCE FROM NORMAL GLOBE VALVE PERFORMANCE, REPLACING GUESS-WORK WITH POSITIVE AND ACCURATE CONTROL OF STEAM, AIR, GASES, FLUIDS, ETC.



VEE-REG Valves incorporate a protected shut-off seating which ensures complete elimination of wire-drawing.

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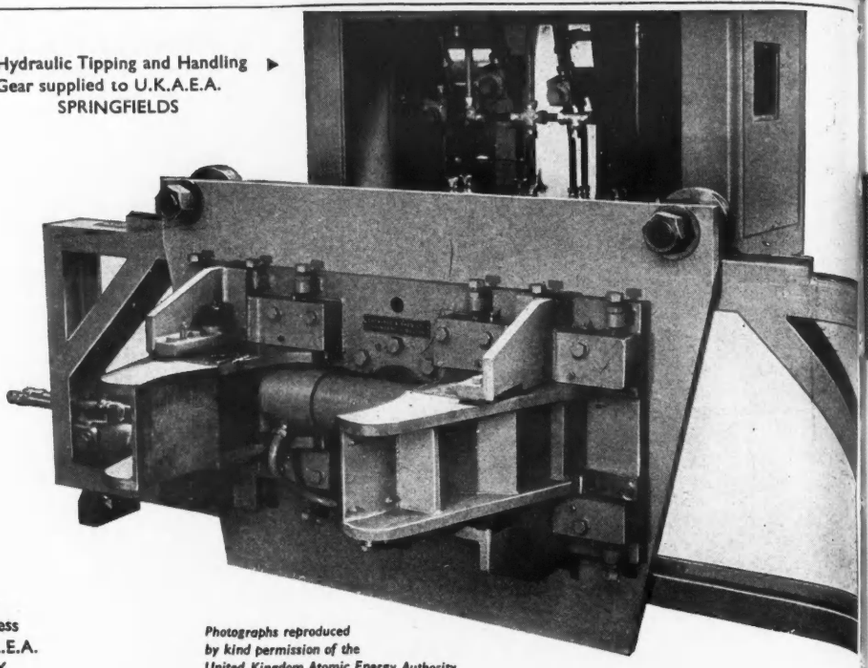

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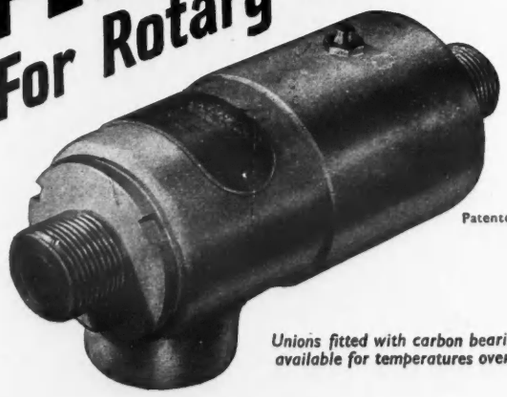

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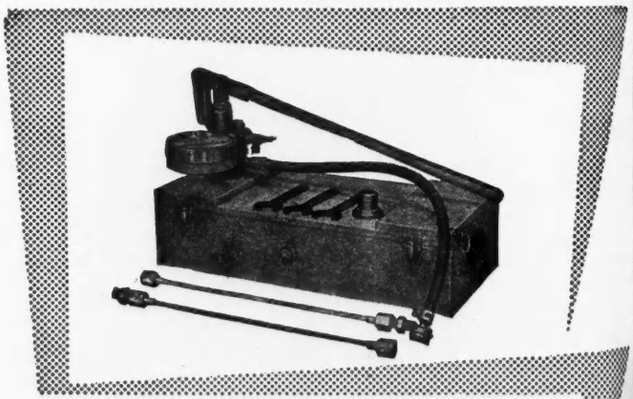

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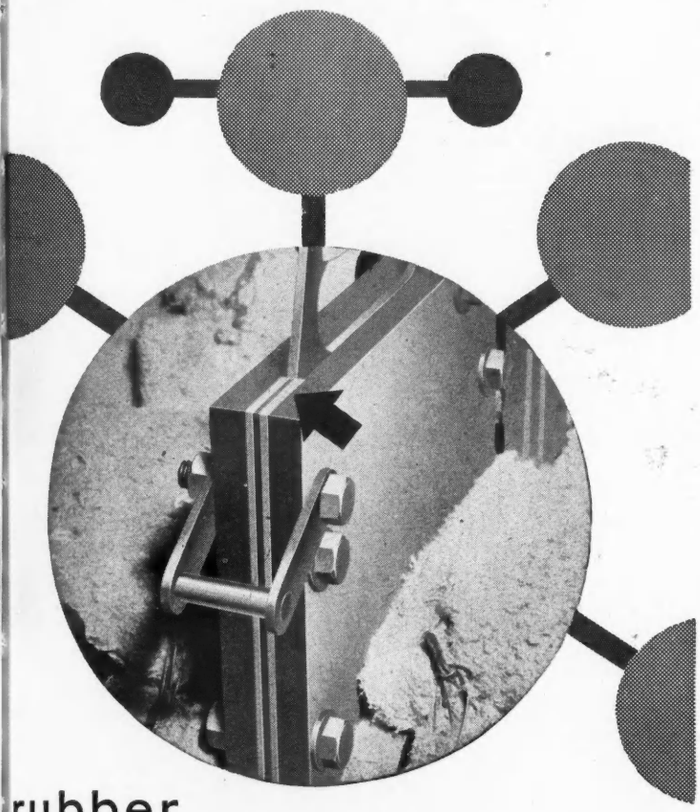

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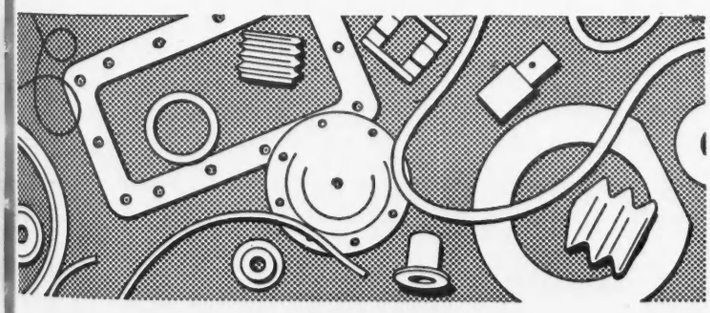

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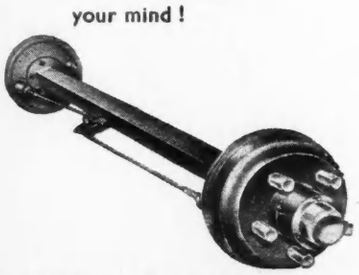

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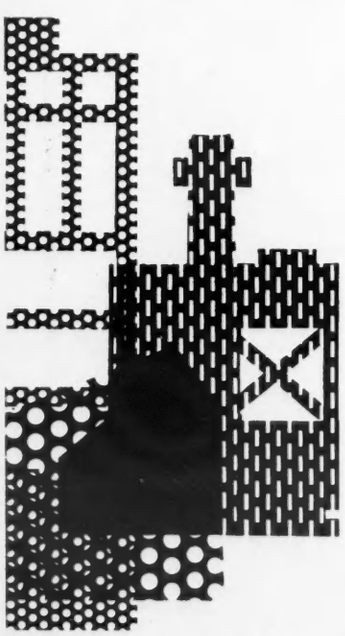

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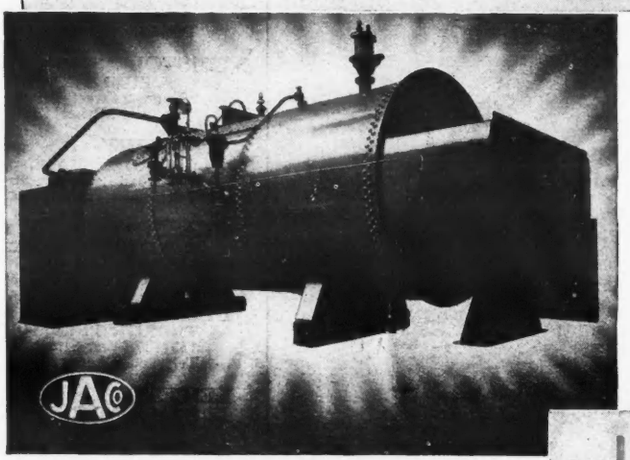

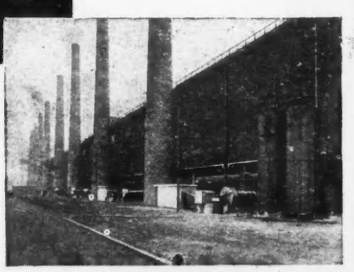

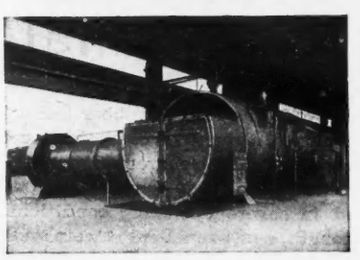

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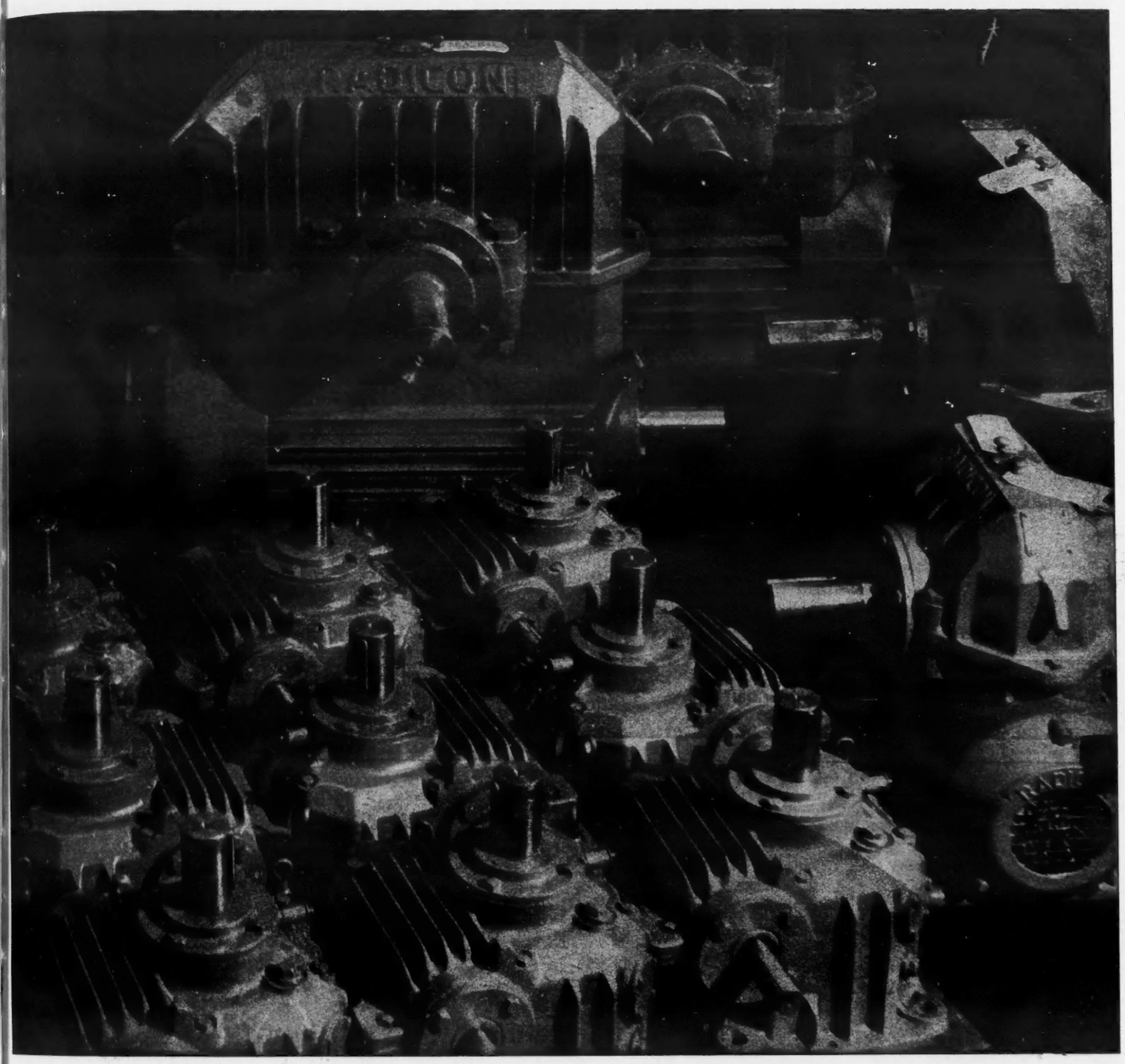

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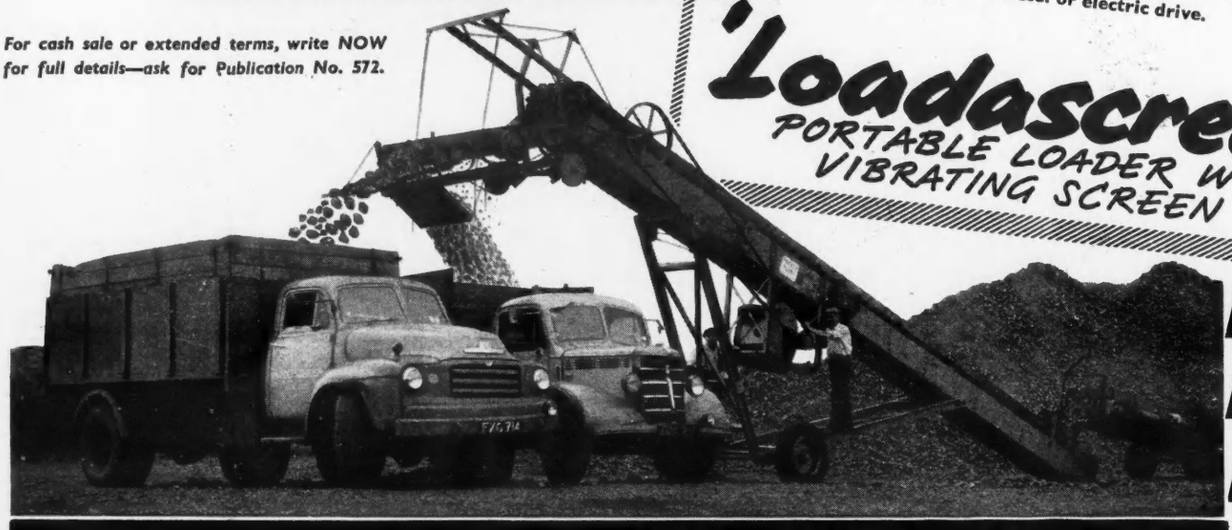

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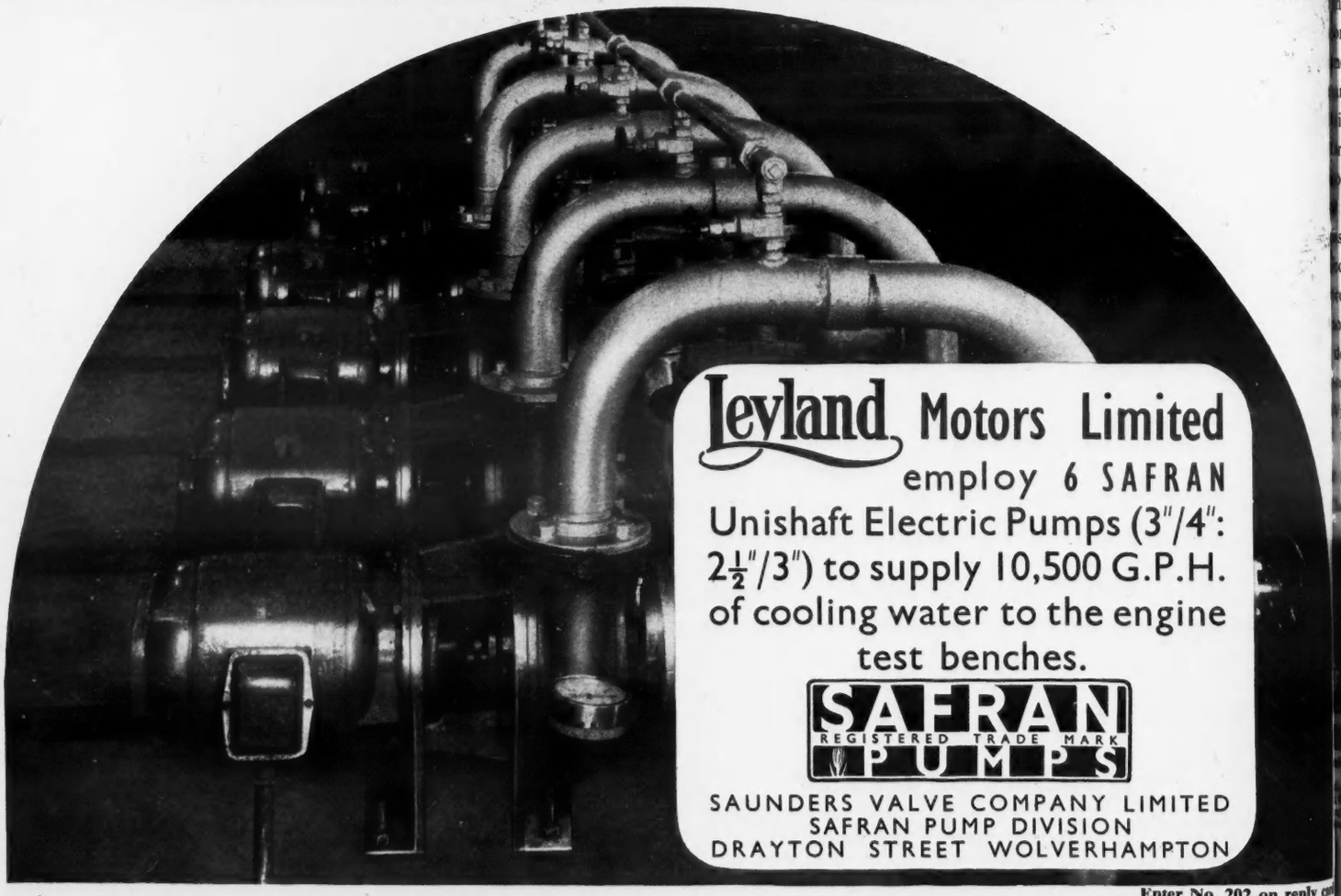

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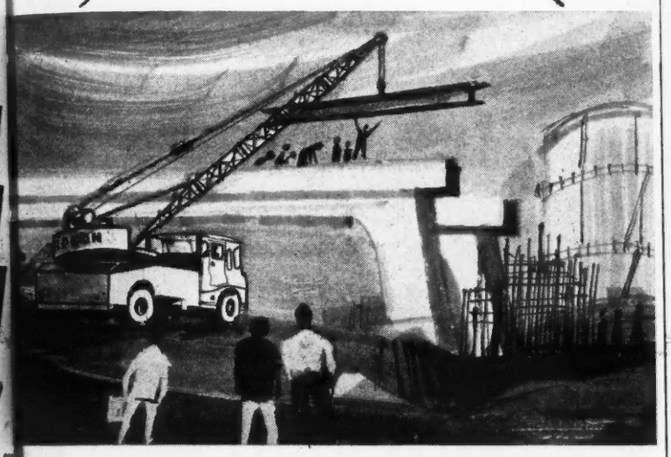

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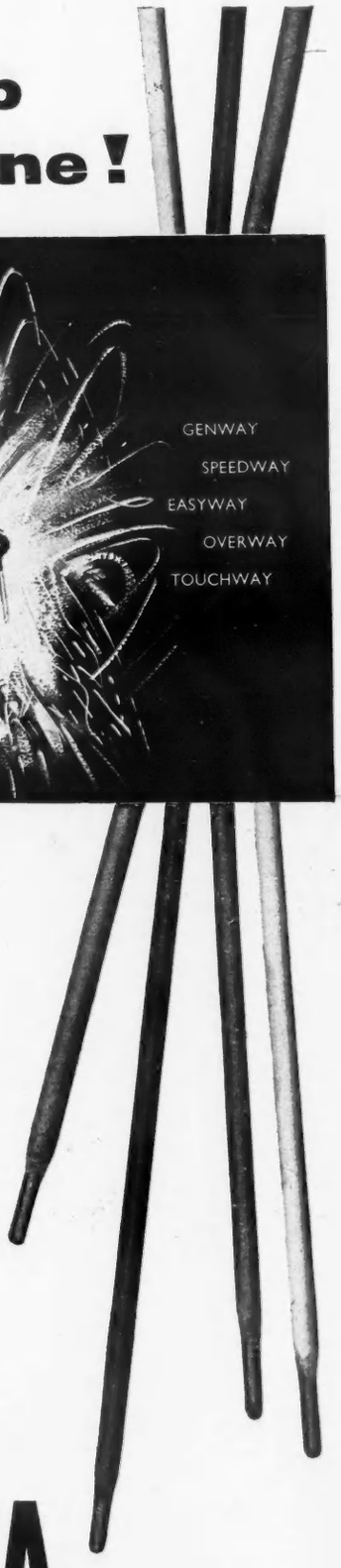

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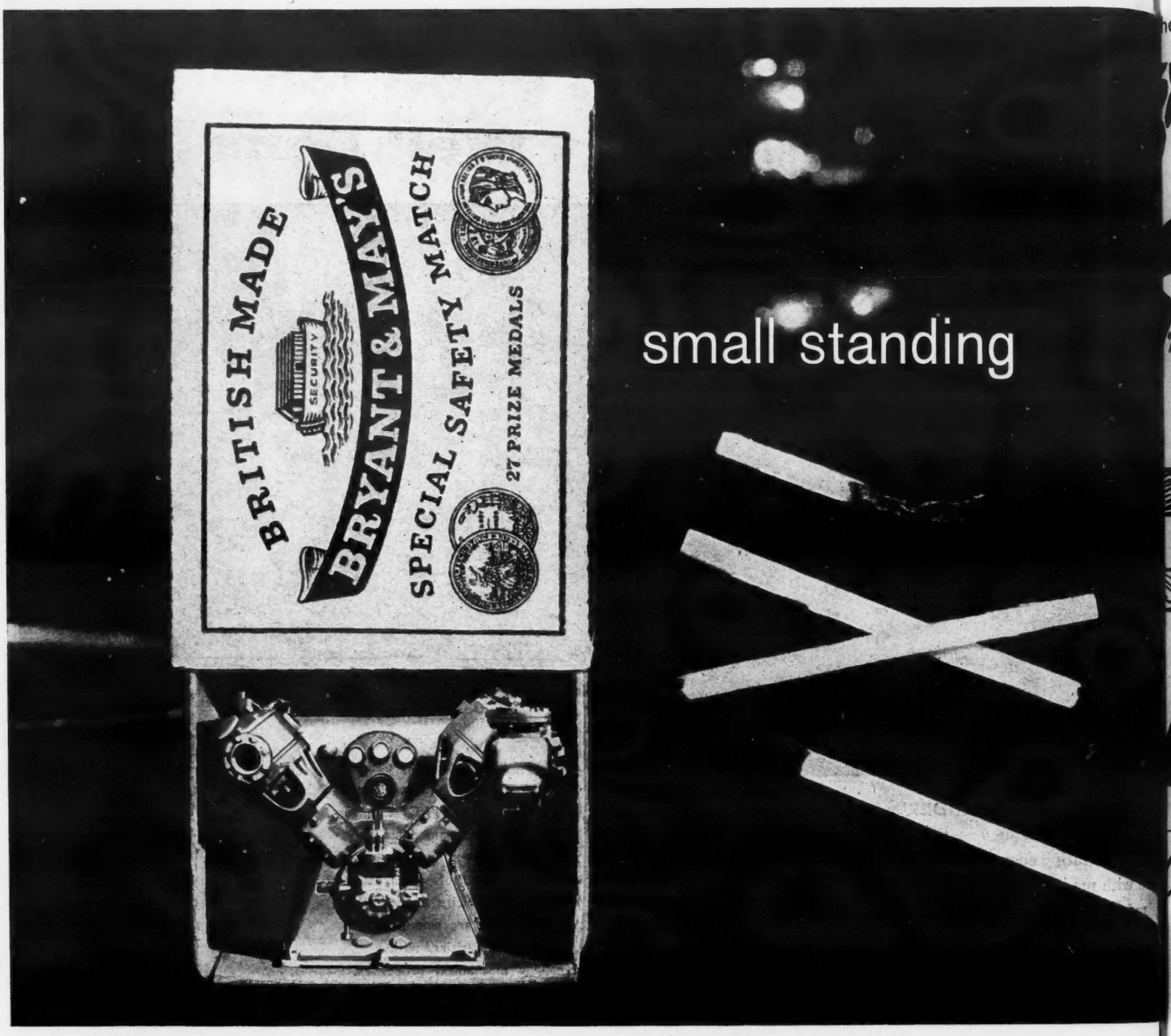

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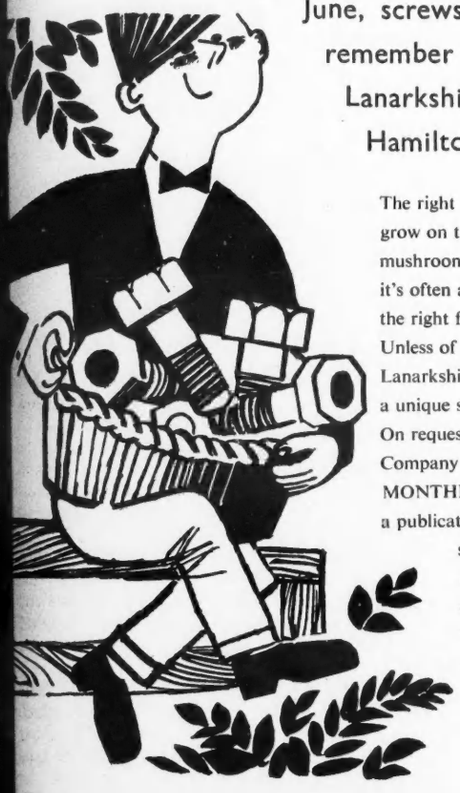

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The illustration shows an Interlock guard in use on a hydraulic press producing engine components.

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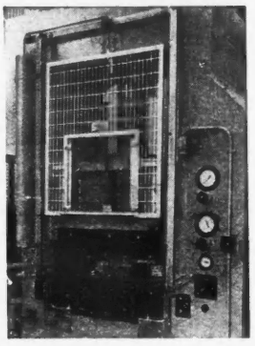

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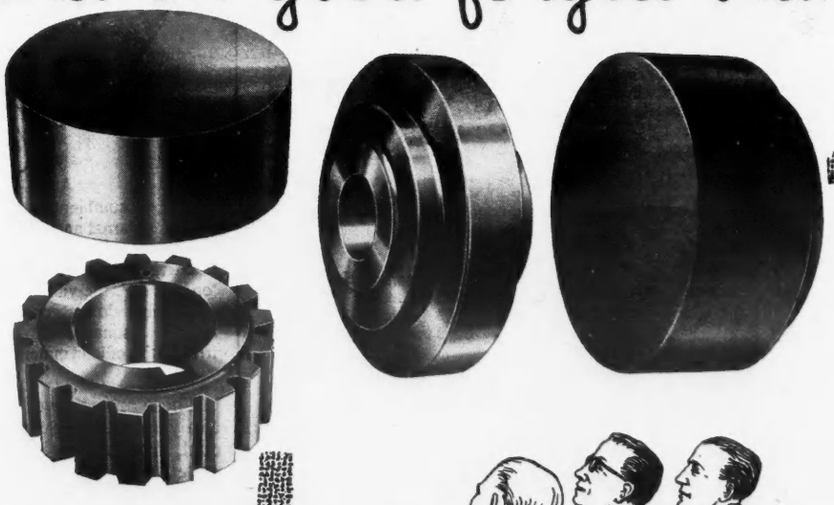

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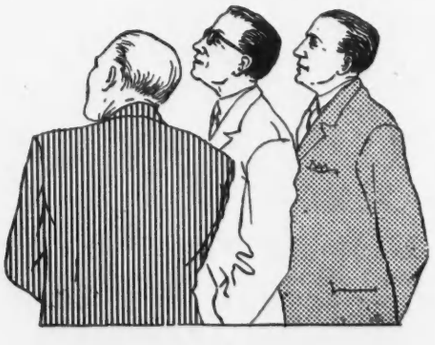

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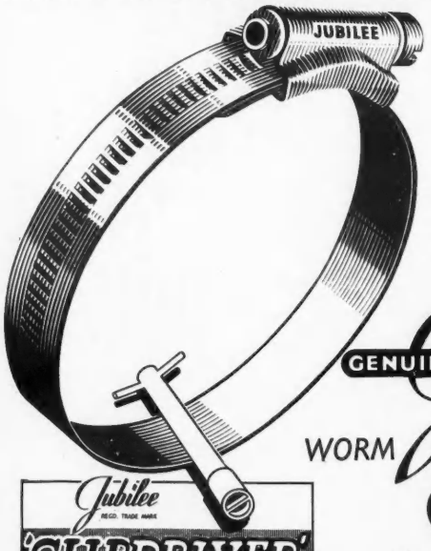

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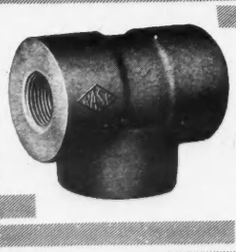

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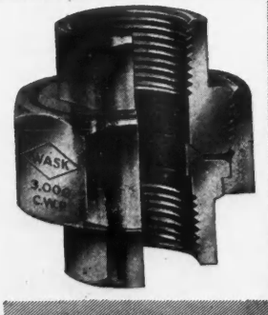

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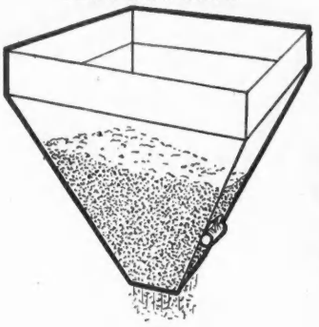
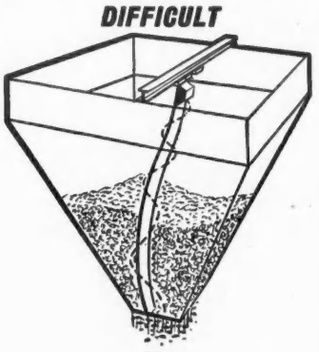


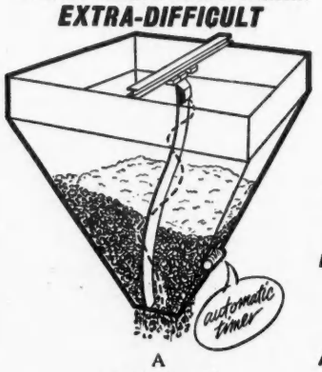
The installation of an external vibrator to a steel hopper.

DIFFICULT



The vibrating reed for application where external vibration is impractical due to structural or other difficulties and if the bunker is made of concrete.

EXTRA-DIFFICULT



A combination of internal and external bunker vibration. Where the external vibrator is timed for 'on and off', the vibration frequency, on slowing down, goes through the natural resonance of the bunker, irrespective of load material contained.

trouble-free bunker discharge

The primitive, inefficient method commonly used for clearing material which sticks in a storage bunker is by applying a sledge hammer to the side of the hopper. This is a form of low frequency, uncontrolled vibration. When vibration is applied at the *correct* frequency, the *correct* amplitude and the *correct* point of application, almost any material can be satisfactorily discharged.

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The three examples illustrated show three different combinations which are typical of many applications, but even these, whilst using the same type of unit, can only be effective if the types of unit themselves are placed in the correct position and have the correct frequencies and amplitudes of vibration to suit the characteristics of the material to be discharged.

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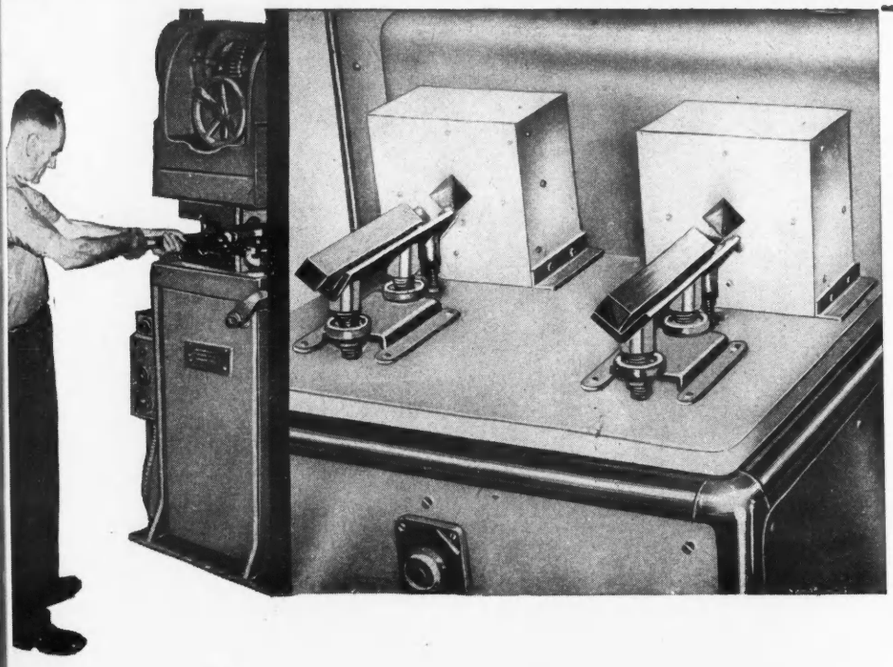

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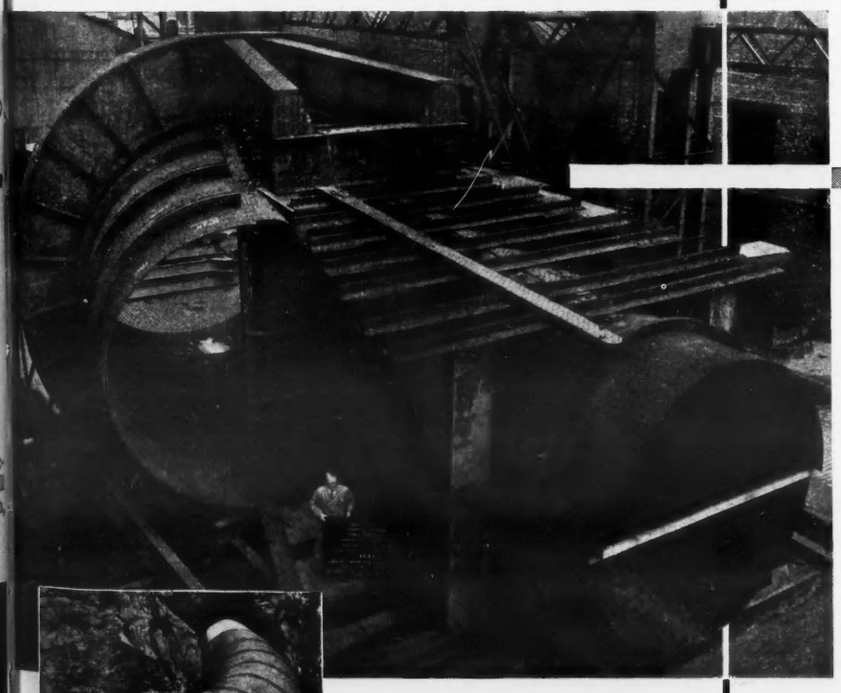

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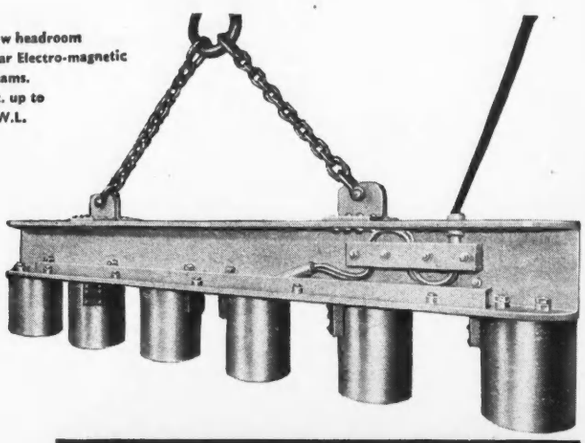
Above: Drum Lifting Device type FLR 10 which releases the load by overlowering of crane.

Right: Low headroom Multi-Polar Electro-magnetic Lifting Beams. 6 to 10 ft. up to 5 tons S.W.L.



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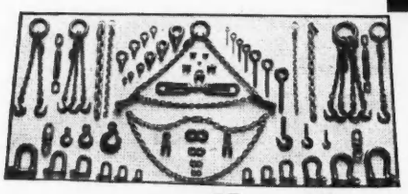

Above: Selection of chain slings and attachments.

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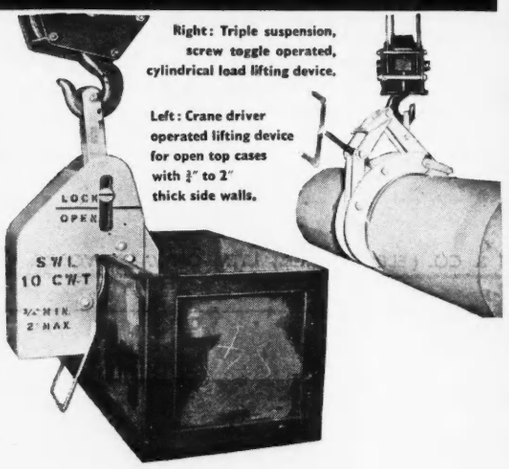

Right: Triple suspension, screw toggle operated, cylindrical load lifting device.

Left: Crane driver operated lifting device for open top cases with ¾" to 2" thick side walls.

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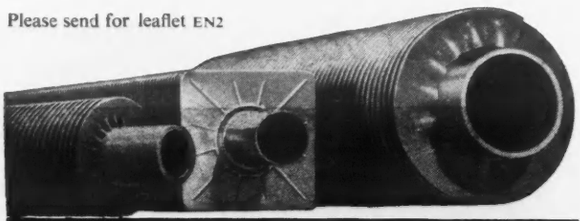

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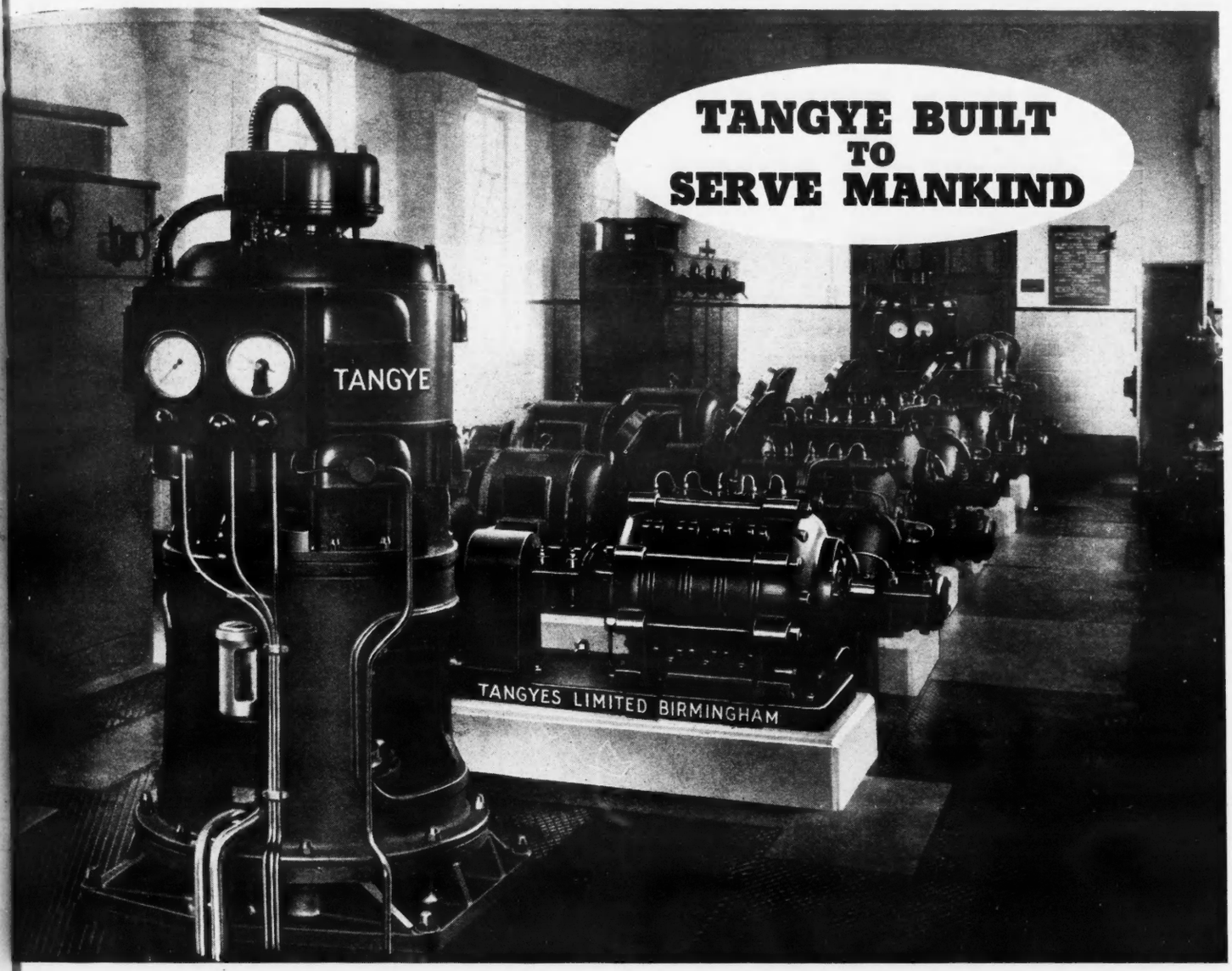

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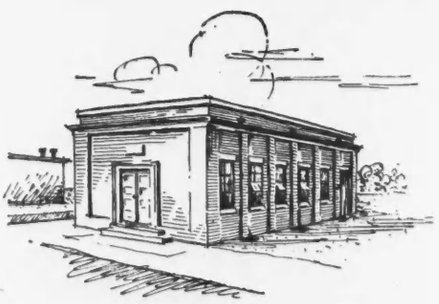

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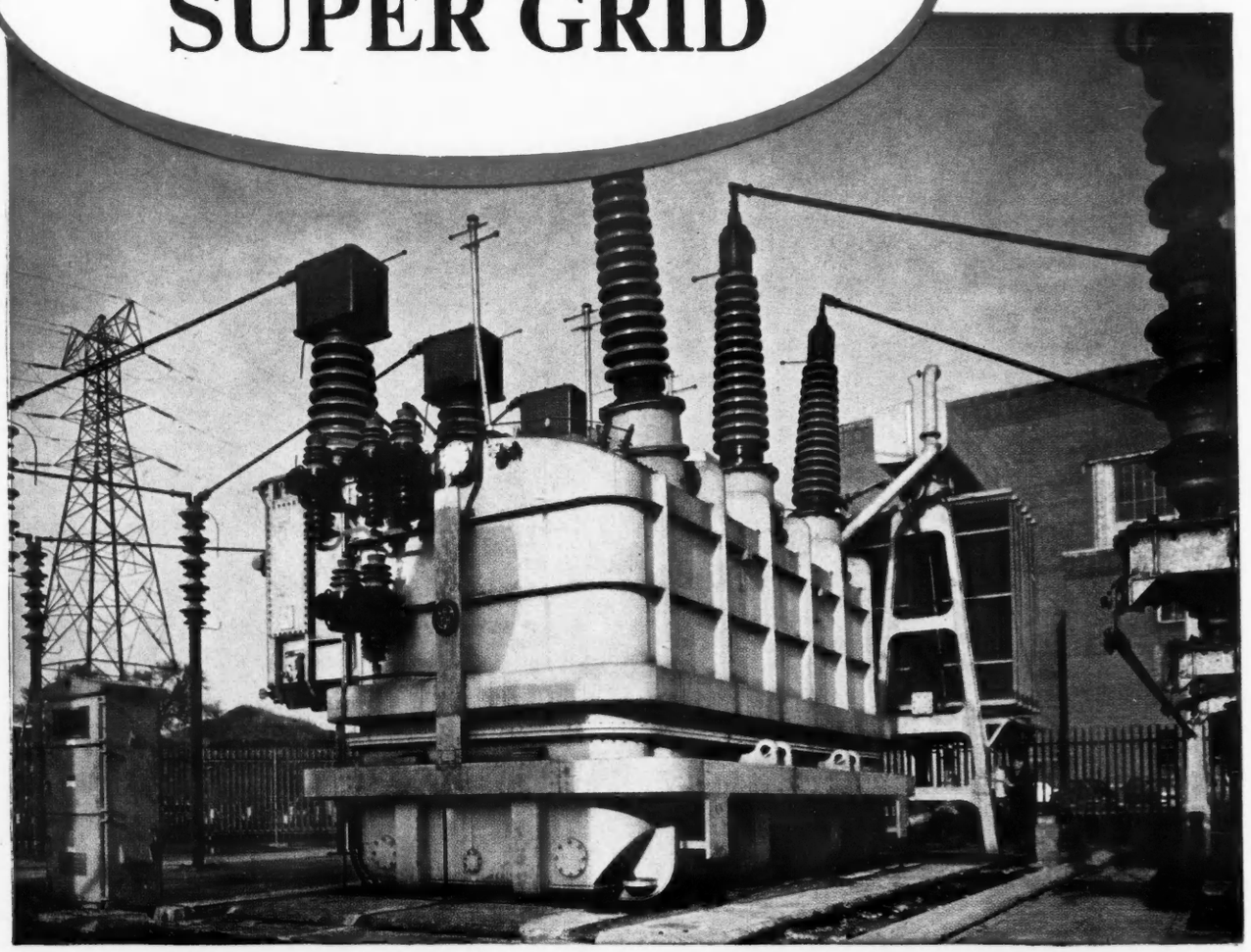

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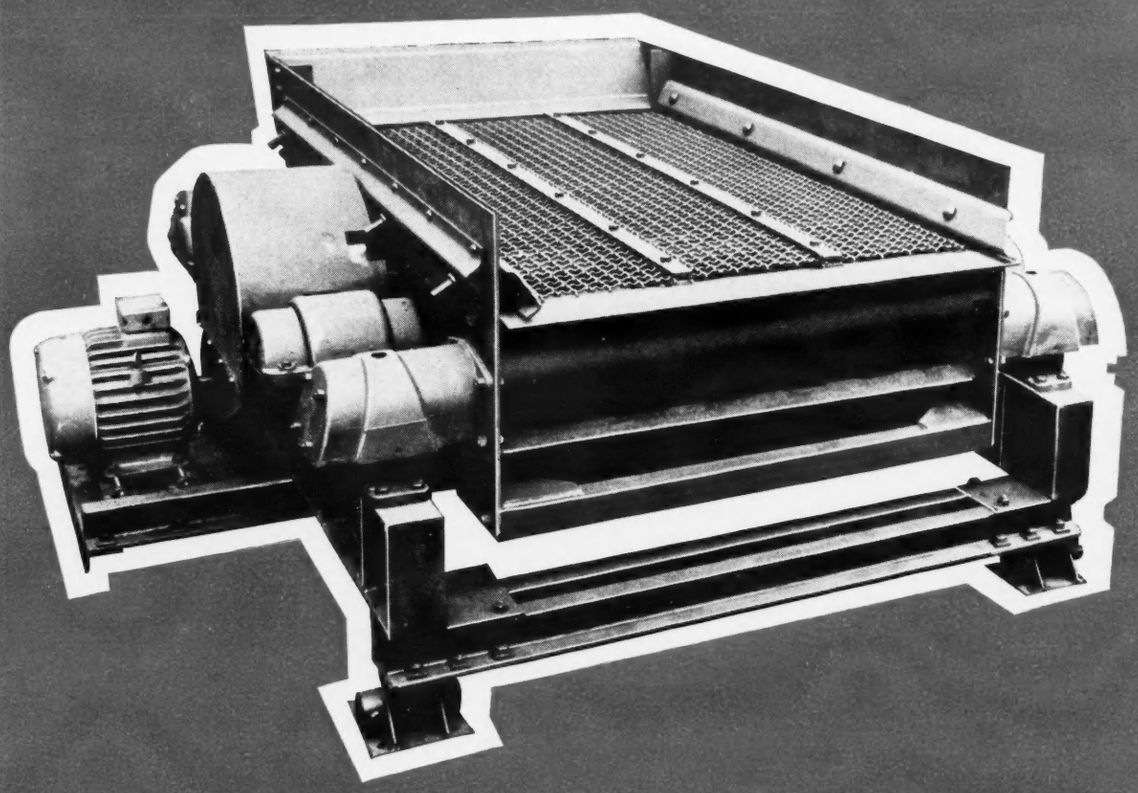

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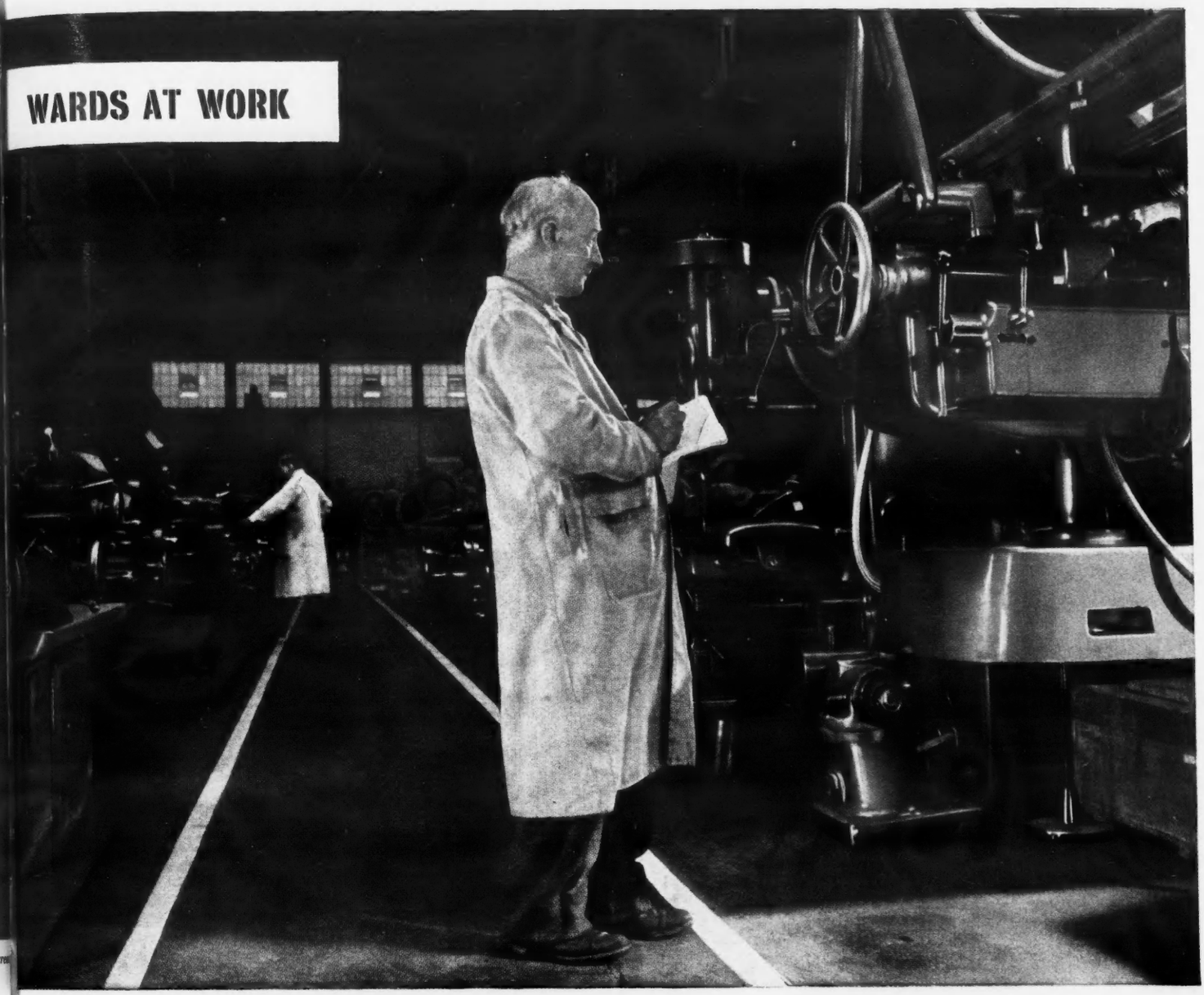

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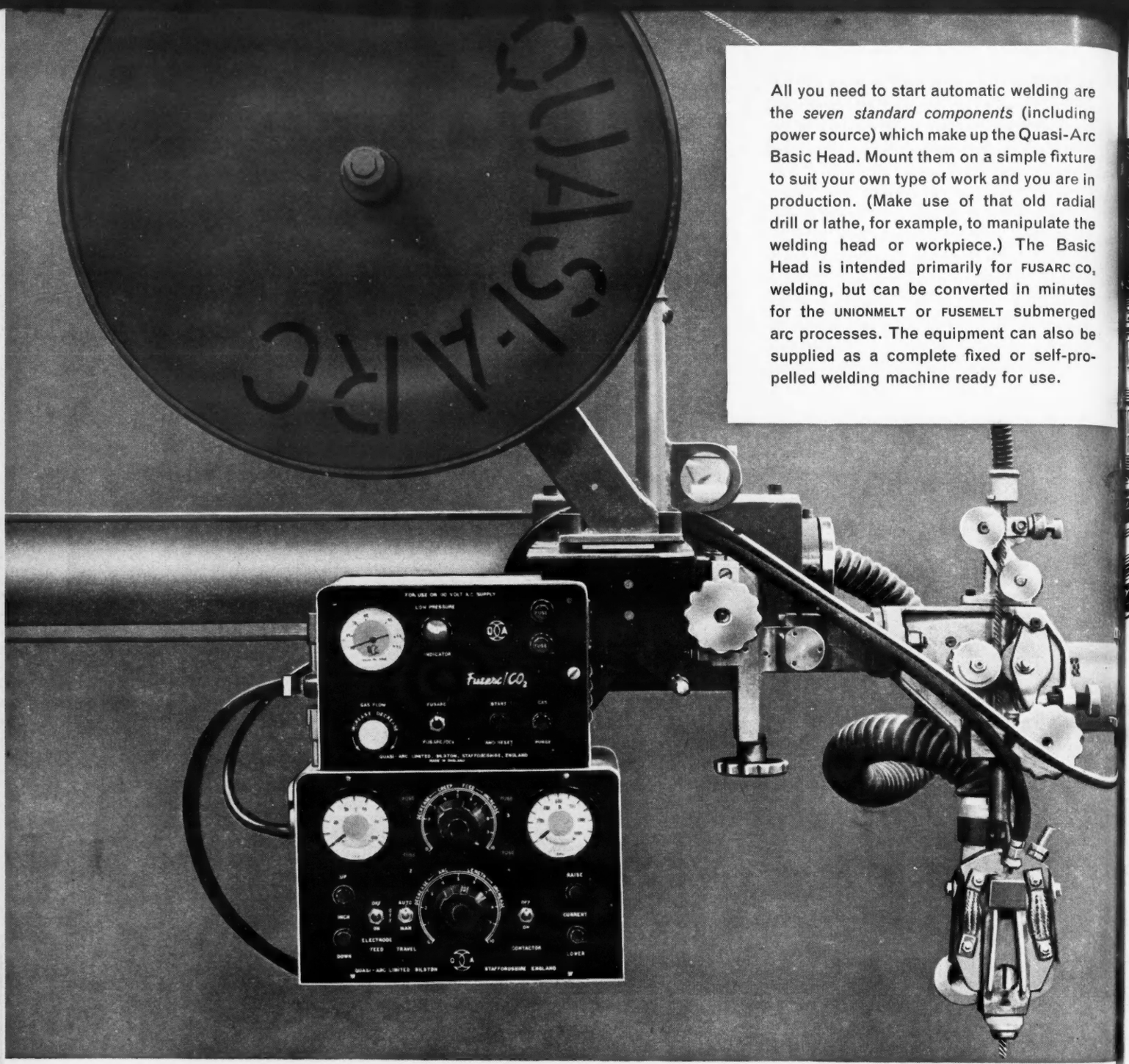

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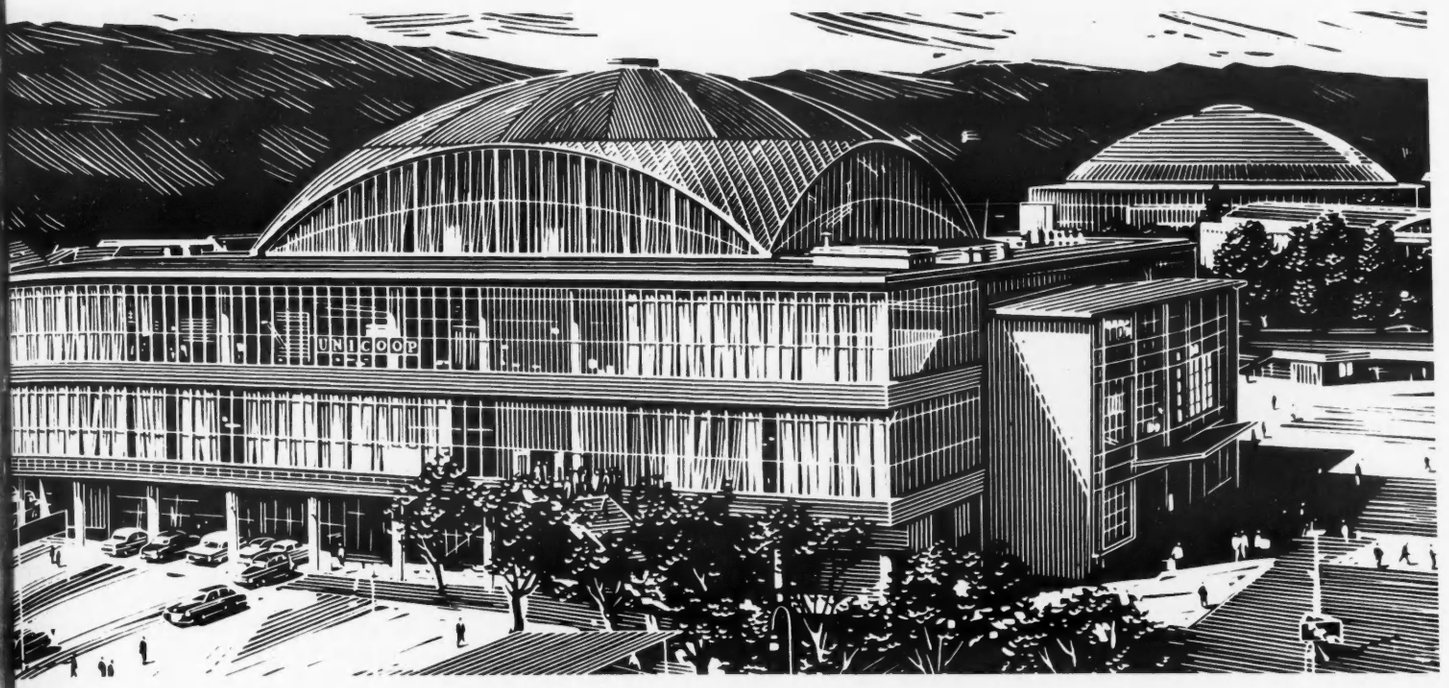

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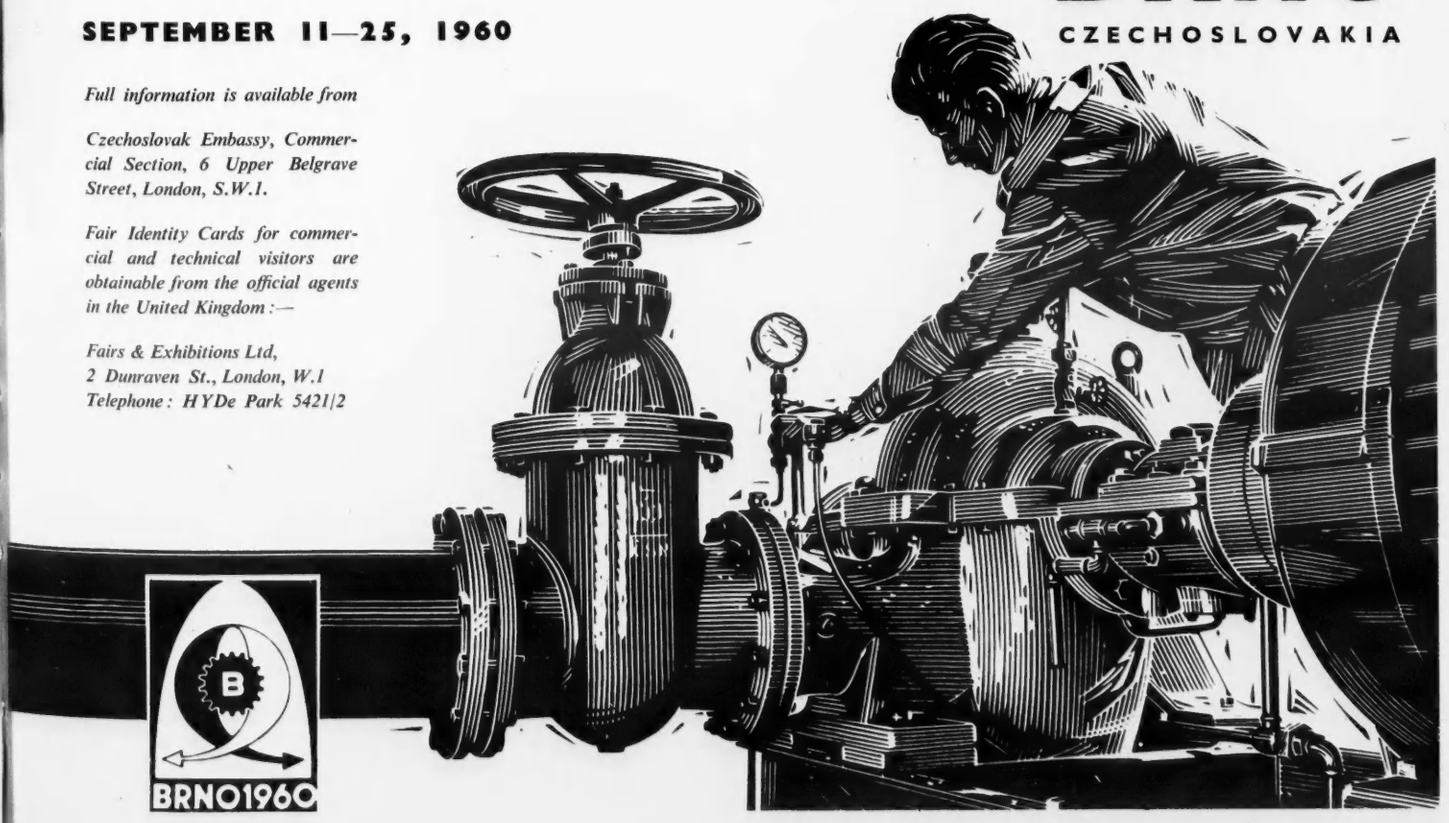

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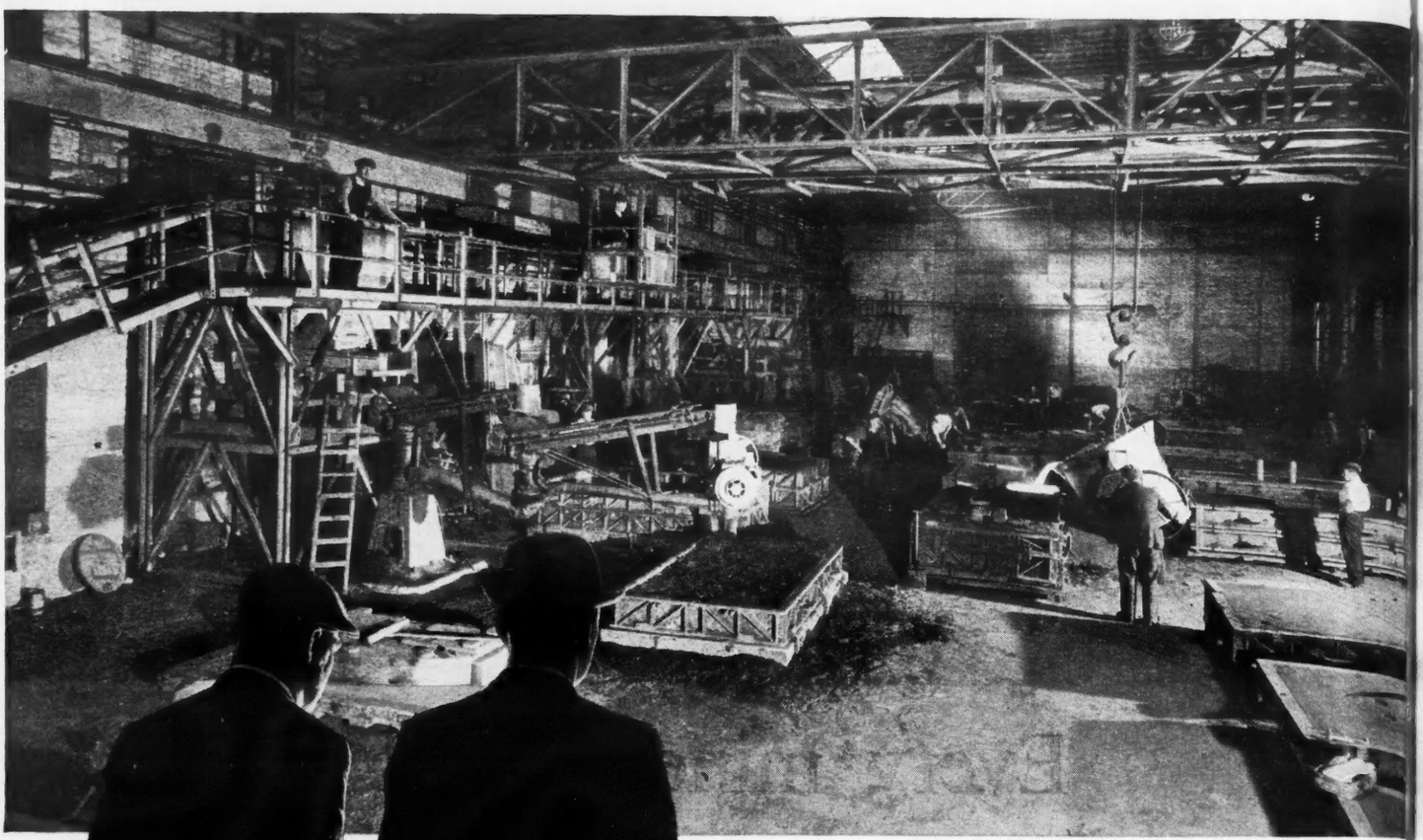

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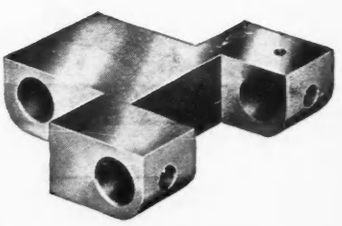

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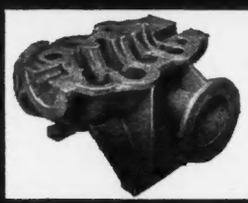

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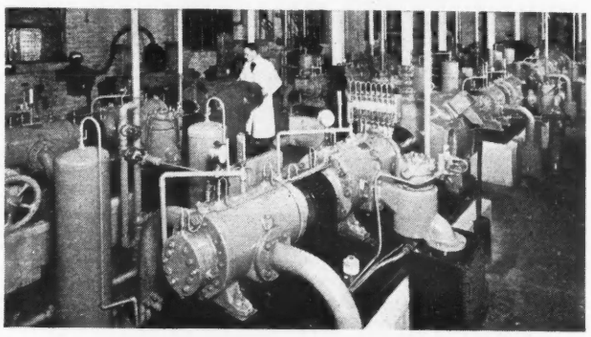

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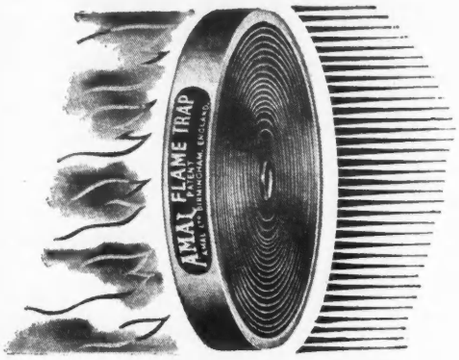

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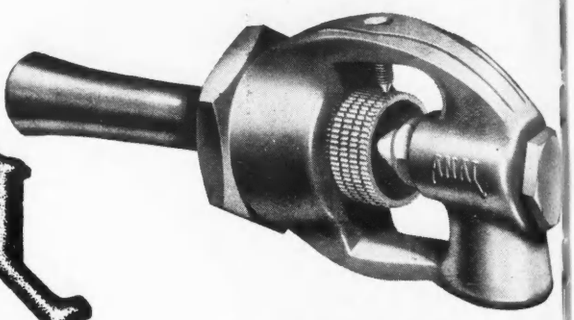

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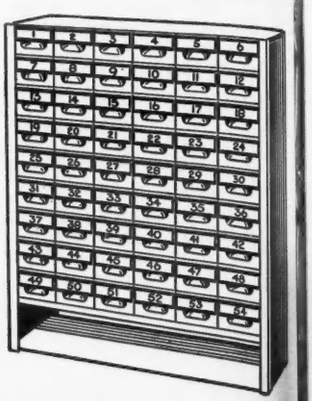

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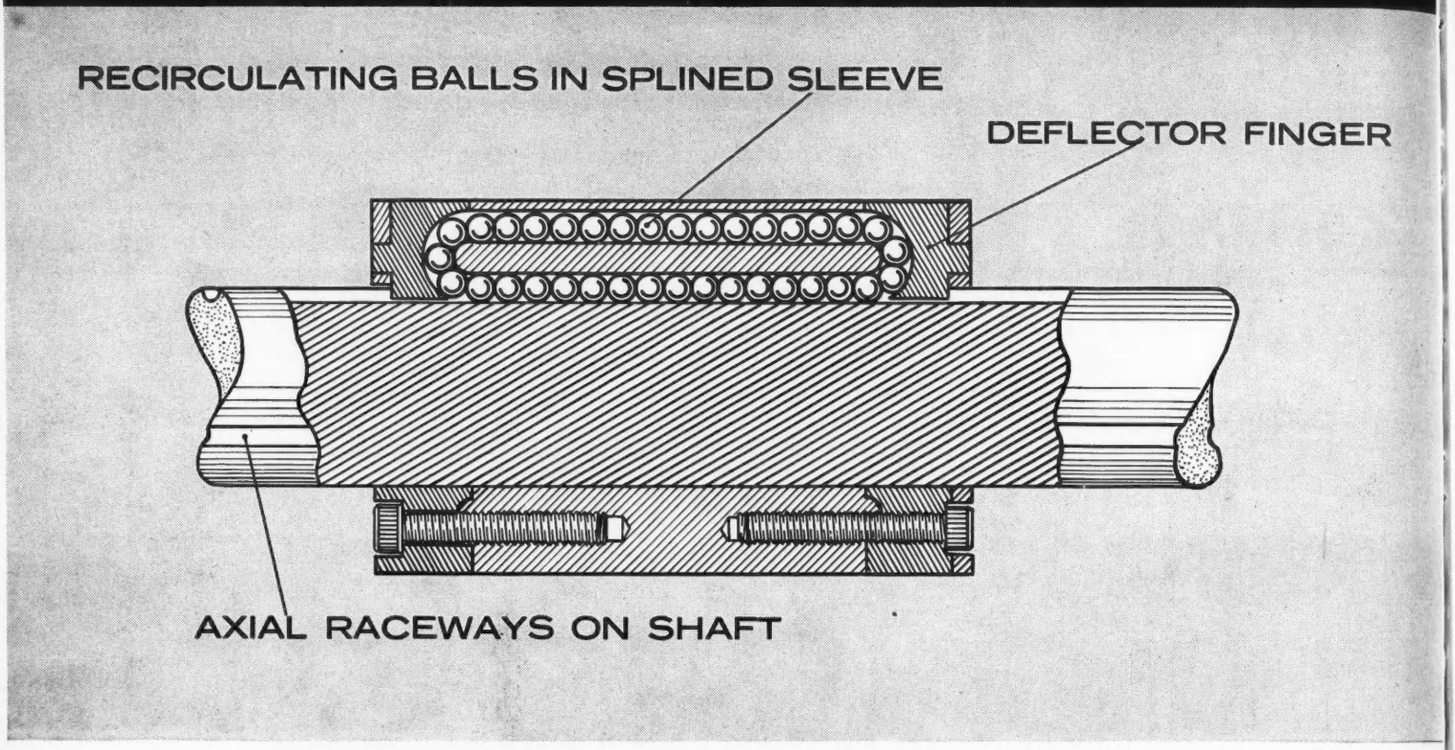

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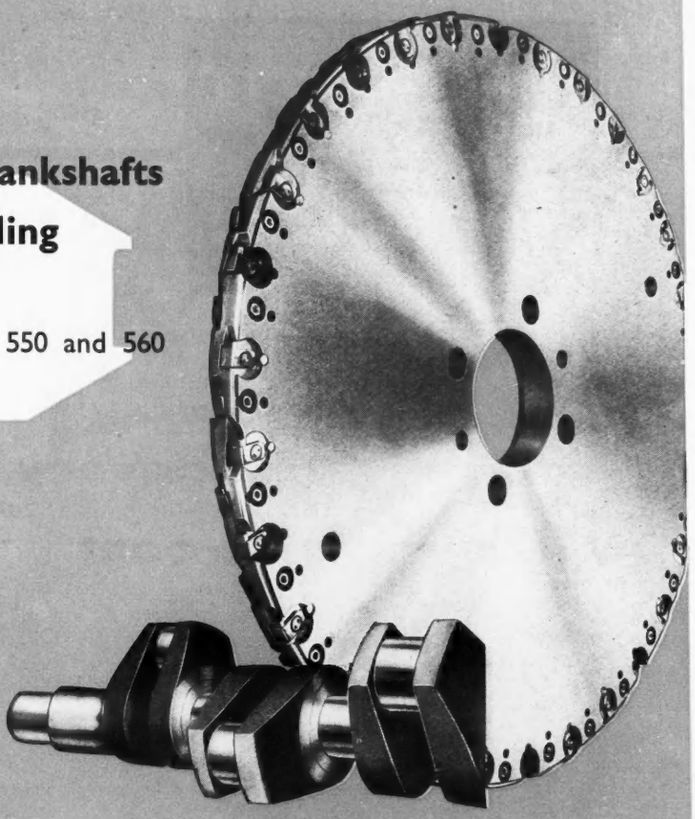

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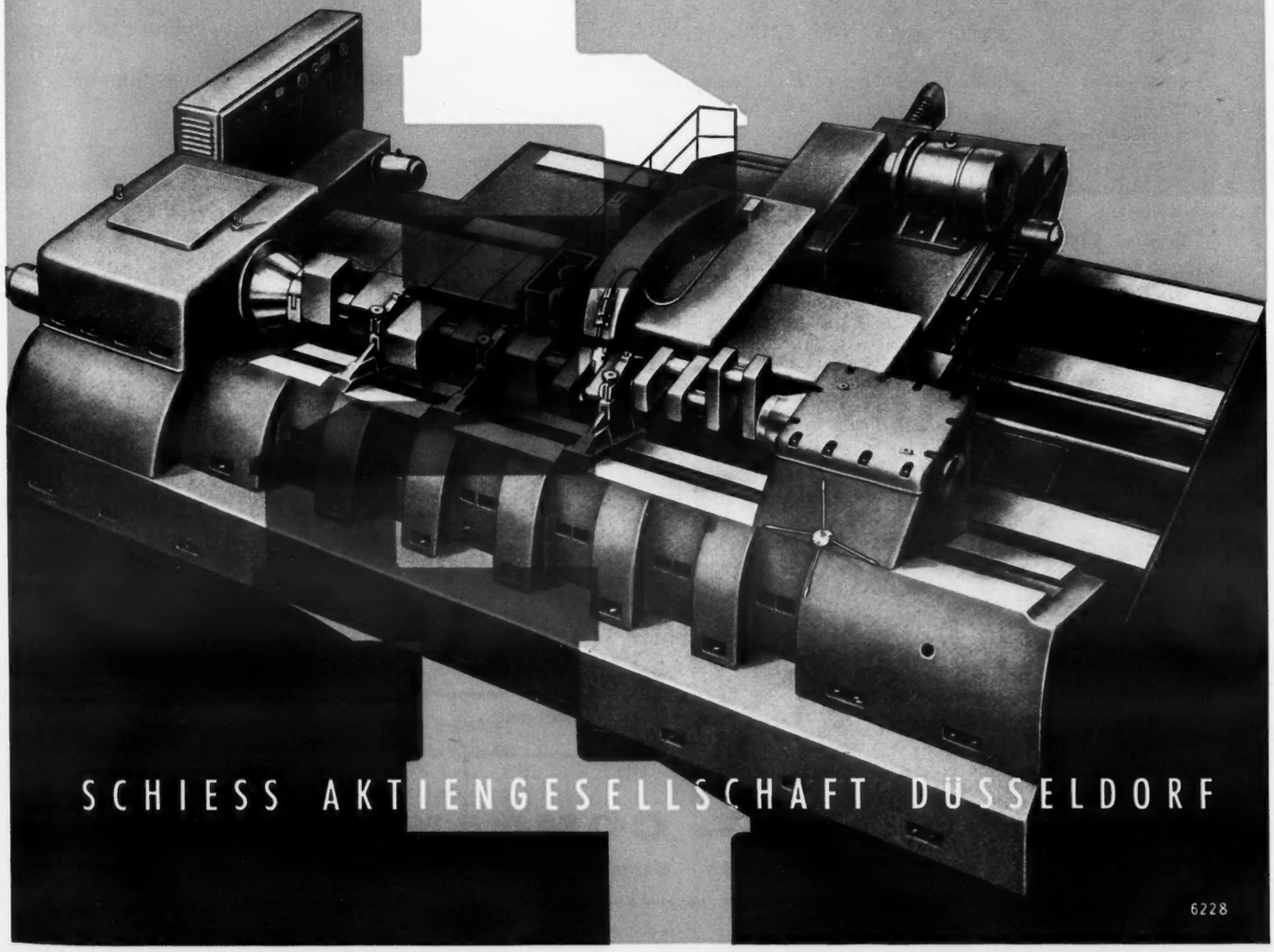

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Water is rapidly becoming scarce and more costly. In many industrial areas the demand already exceeds the supply: this is forcing users as well as Public Authorities to conserve available resources.

This situation can be alleviated by re-claiming waste water and purifying it for re-use: shown here is the control panel of a plant for this purpose recently designed and manufactured by Permutit for Messrs. Heinz at Kitt Green, nr. Wigan. With a capacity of some two million gallons daily, this plant recirculates process water and renders it pure and sterile. Not only does this produce valuable savings in water costs, it also reduces considerably the load on the local water supply.

The Permutit plant at Messrs. Heinz new Kitt Green Factory is designed for a maximum flow of 110,000 gallons per hour. It embodies measuring and proportioning equipment for coagulant, open type gravity sand filters, pH correction gear and final sterilising with chlorine. A particular feature of the plant is that control is fully automatic.

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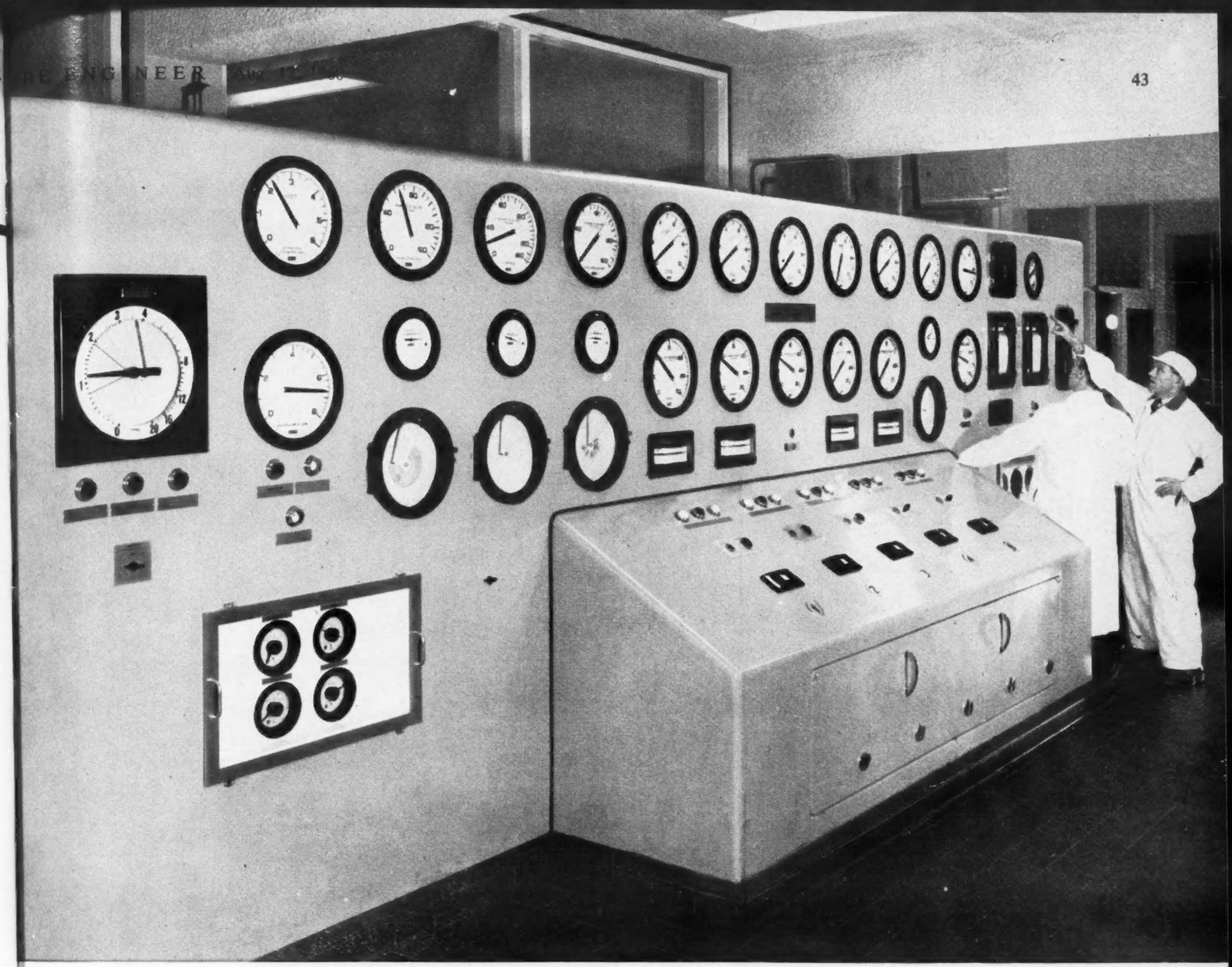
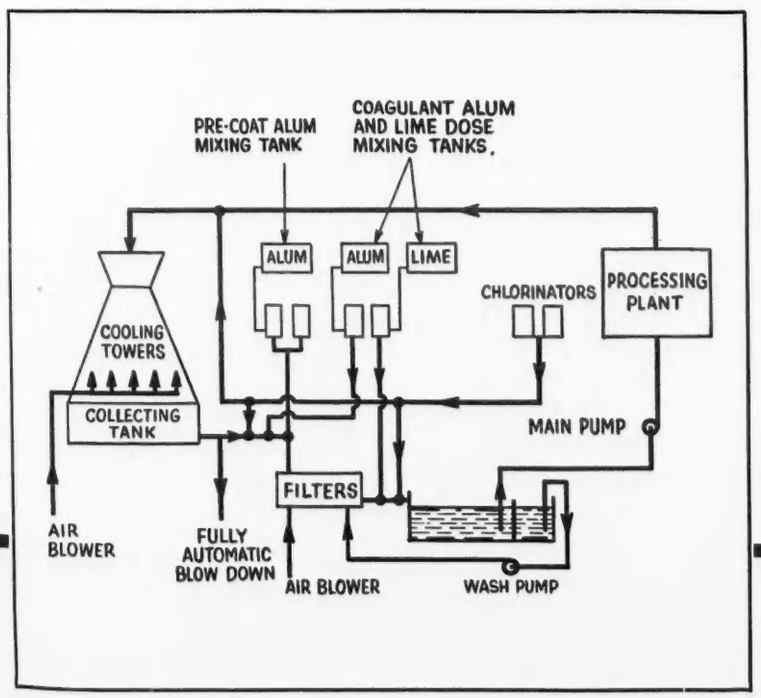
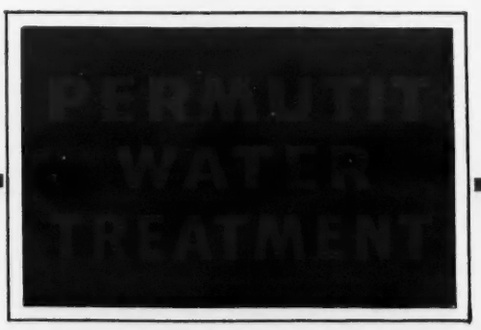




Above is the control panel of the Permutit Water Recovery Plant at the Heinz Food Factory at Kitt Green. The flow sheet for this plant is shown on the left.



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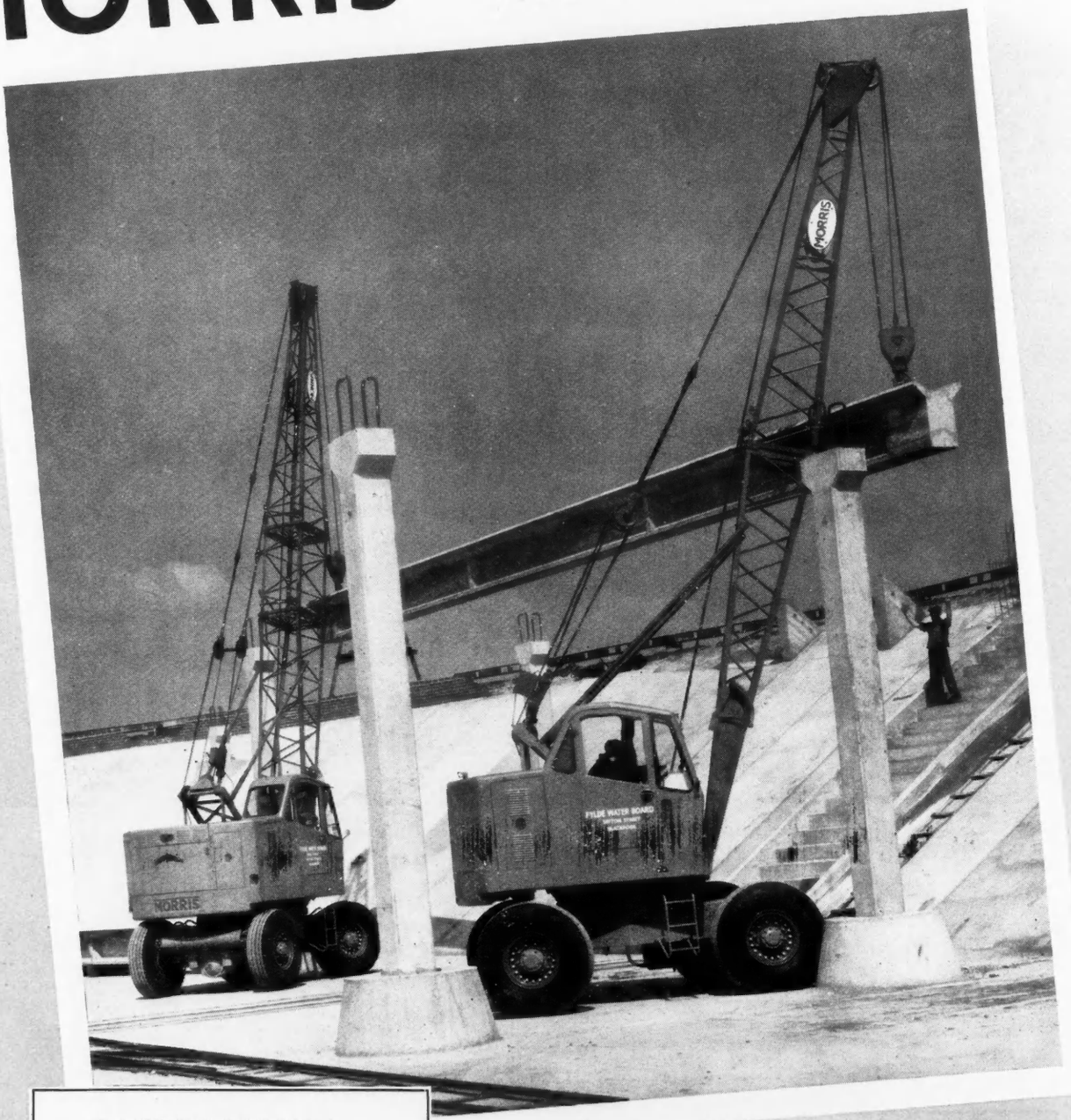

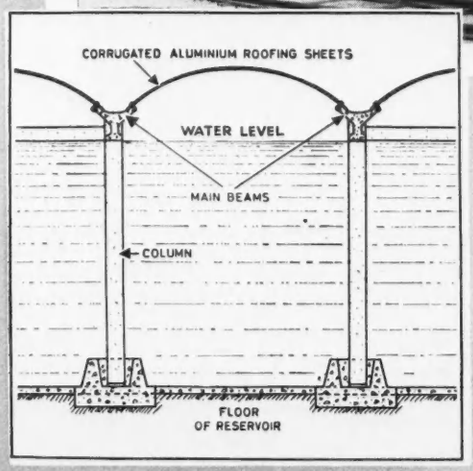

with two M120 Diesel Electric
MOBILE CRANES

The Morris 6 ton mobile cranes illustrated, are erecting the columns and the main beams which will support the aluminium sheet roof of a 16 million gallon concrete lined reservoir now being constructed at Weeton, Lancs., for the Fylde Water Board. Each crane has a 35ft. jib made up of two 15ft. sections and one 5ft. centre section.

The cranes lend themselves admirably to a somewhat unusual situation involving partial dismantling, so that they can be passed through an 8ft. wide culvert leading to the floor of the reservoir basin where they are seen operating.

Although, in this instance, the cranes are shown fitted with strut jibs, the Morris range of mobiles embraces cranes with cantilever jibs, truck and lorry mounted types up to 6 tons capacity in addition to a similar alternative range for loads up to 3 tons.

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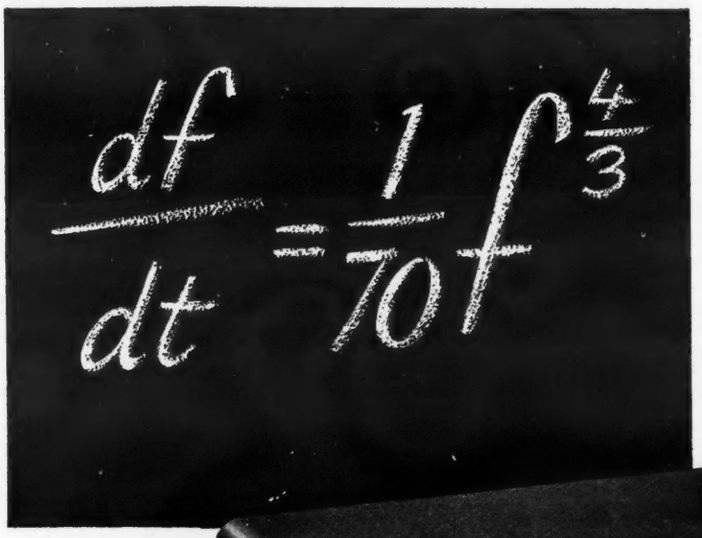

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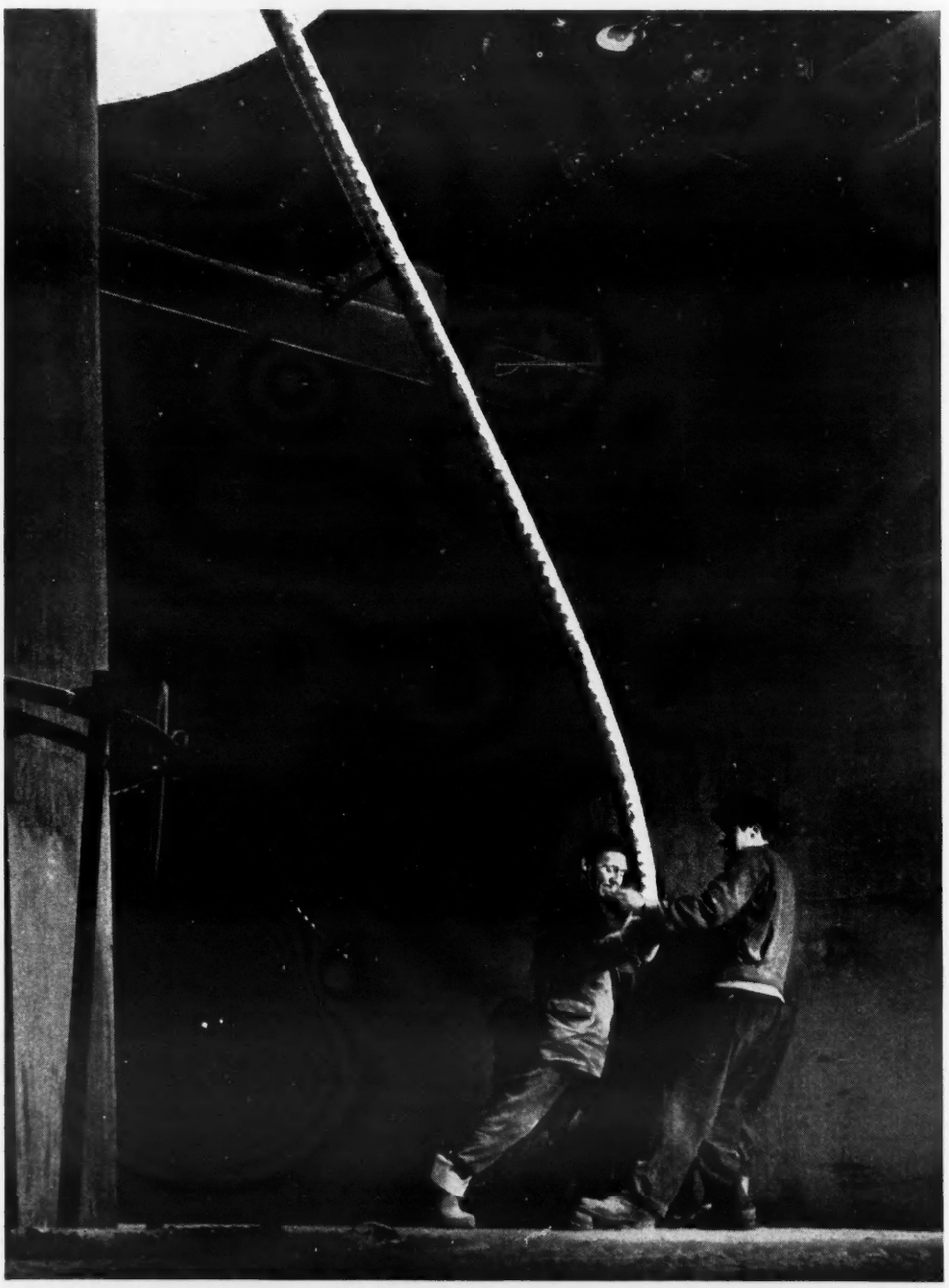
cross-channel power link

The submarine power cable to be laid across the Channel between Dungeness and Boulogne will be similar to the cable shown here. This cable, which now connects British Columbia with Vancouver Island, was manufactured and laid by BICC in unjointed 16-mile lengths.



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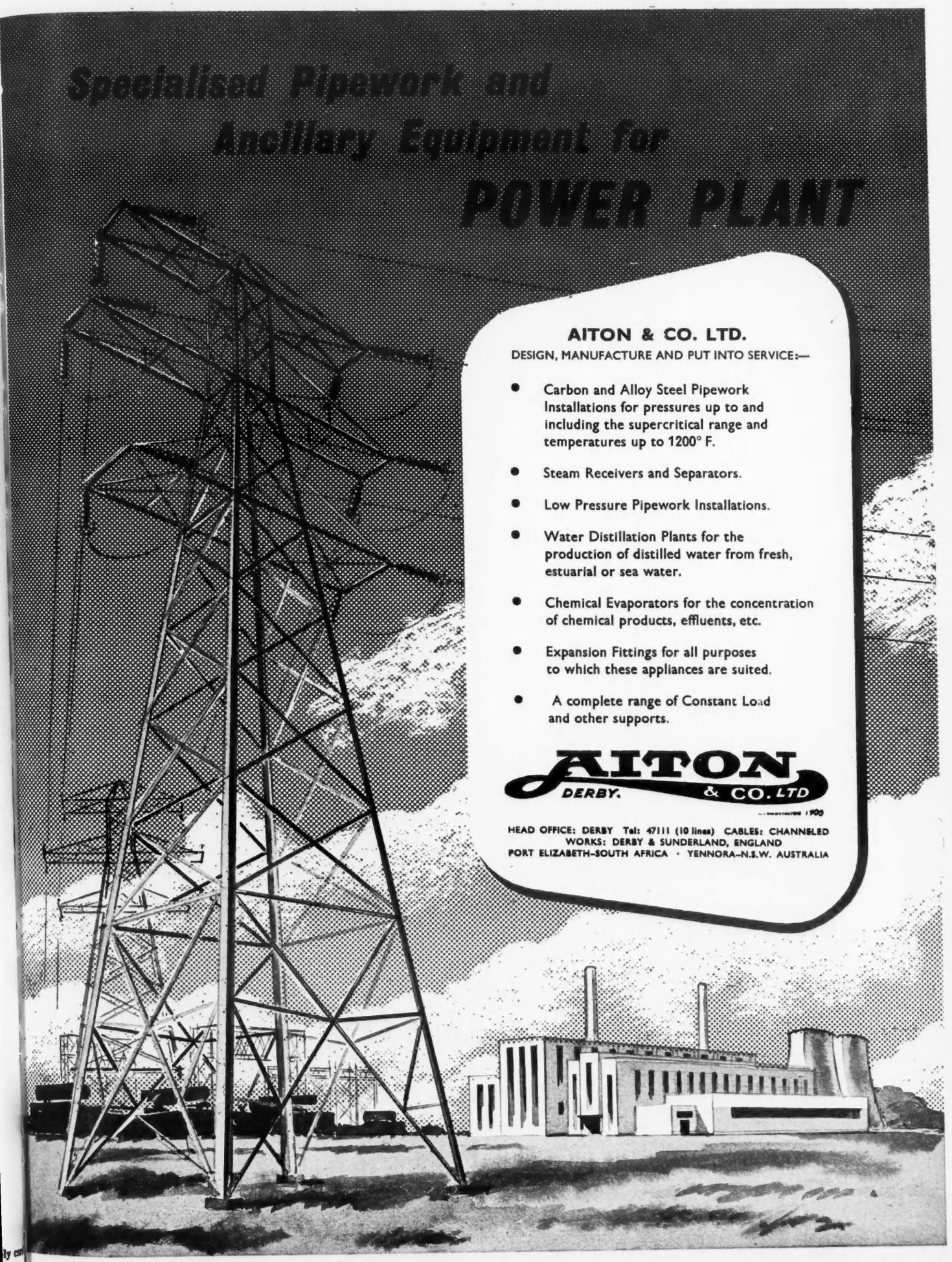

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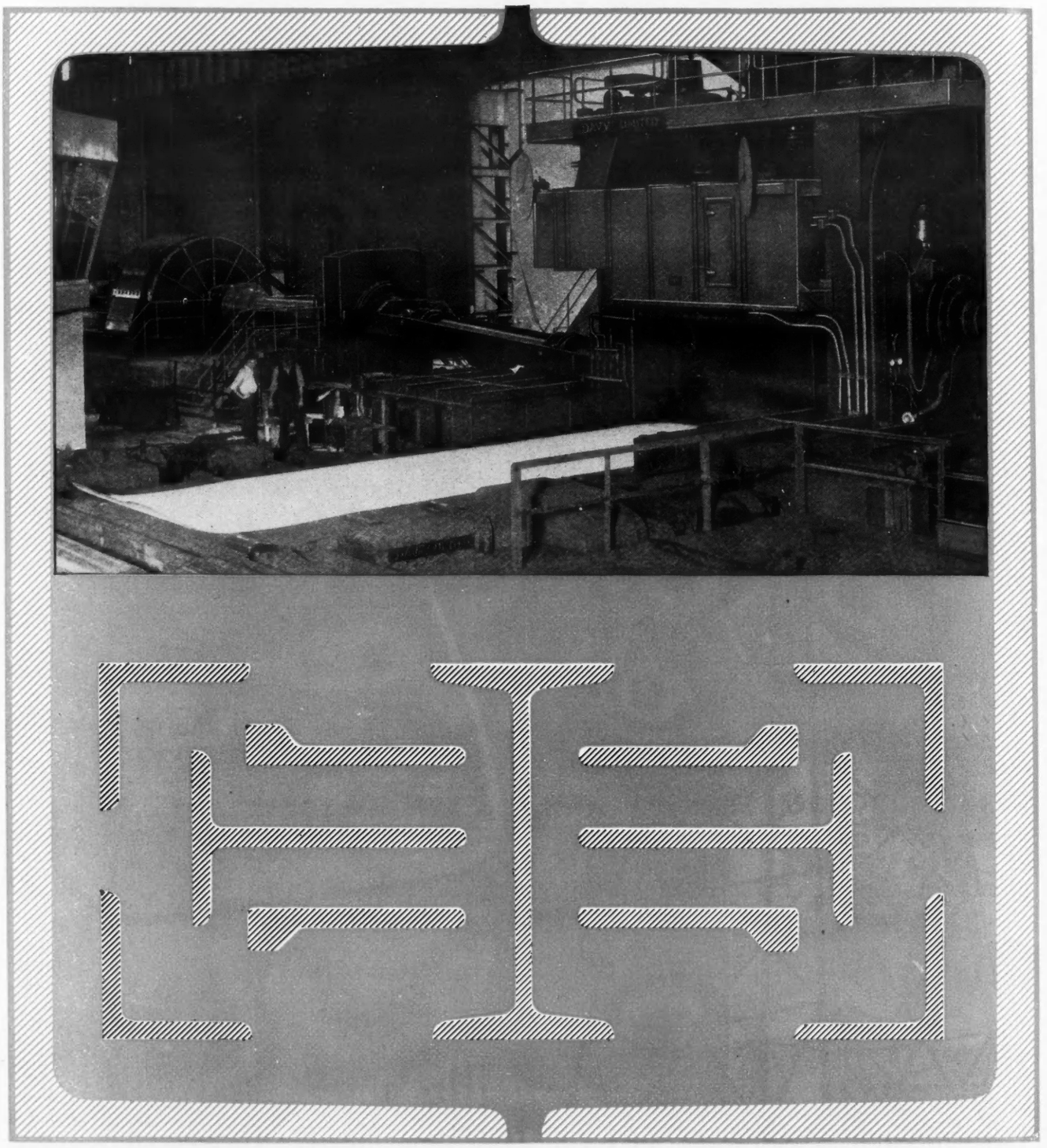

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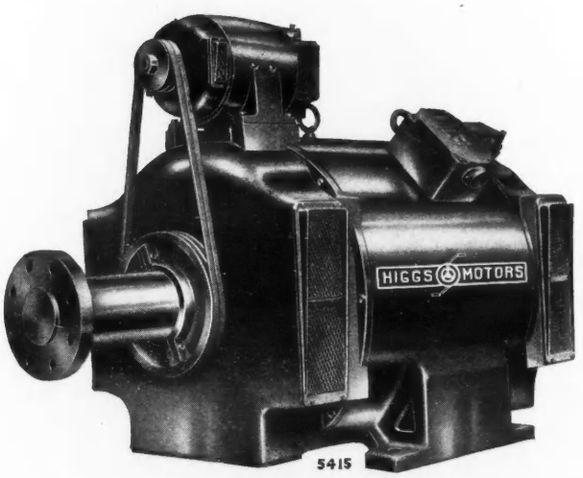

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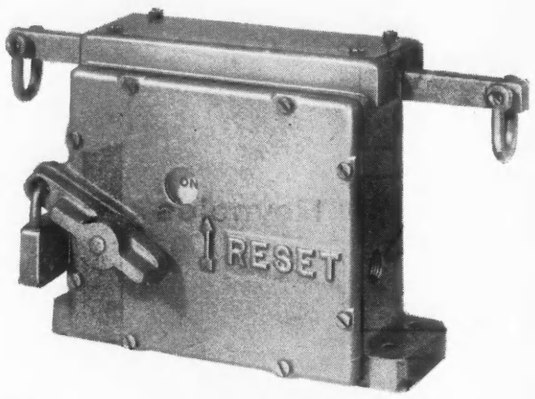

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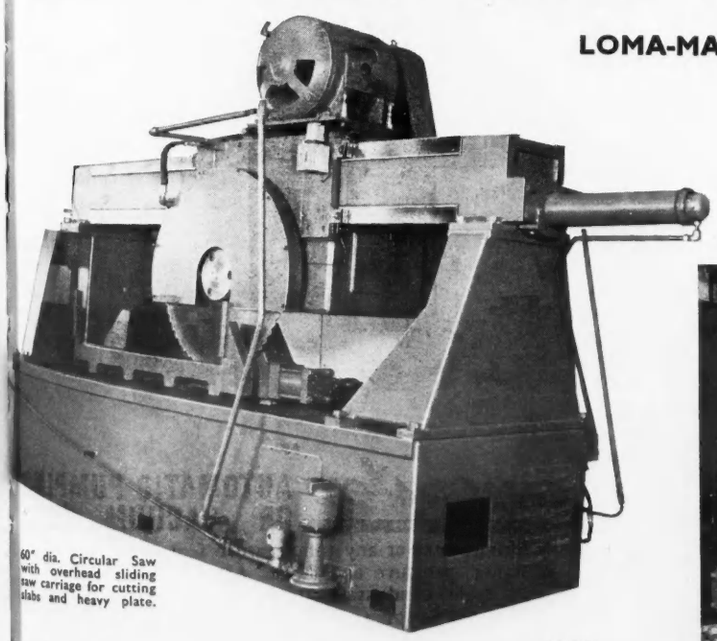
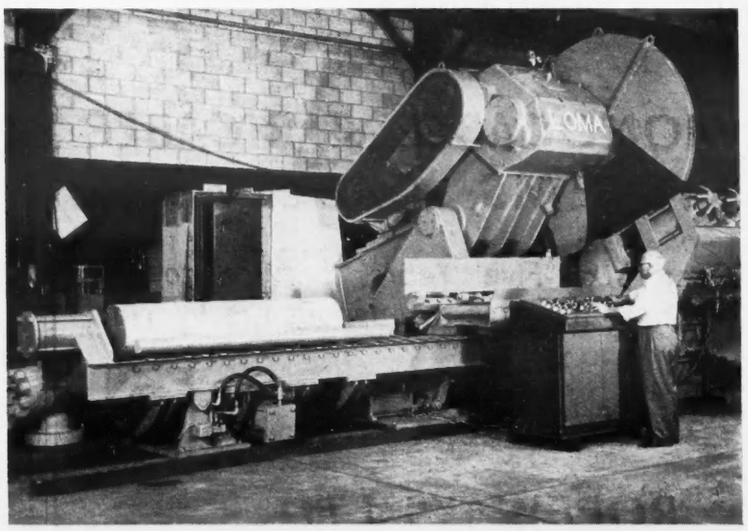


60" dia. Circular Saw with overhead sliding saw carriage for cutting slabs and heavy plate.



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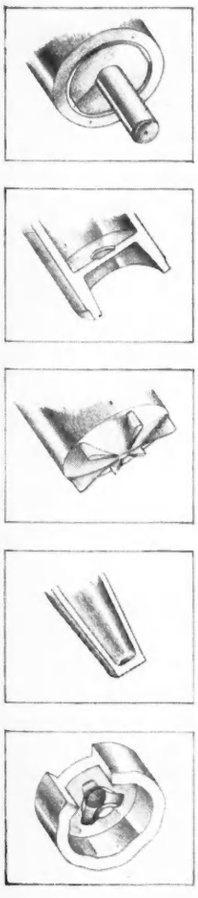

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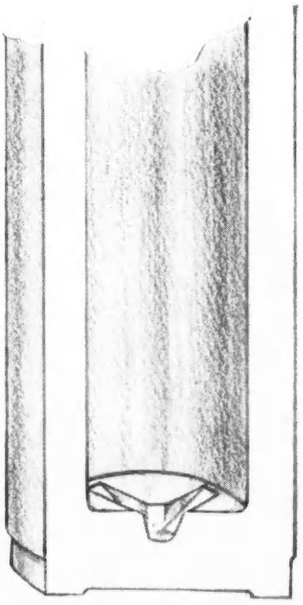

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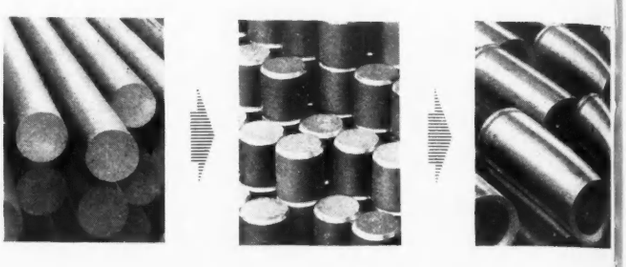

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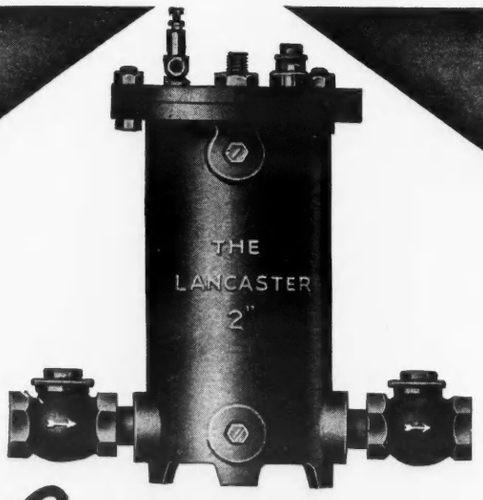

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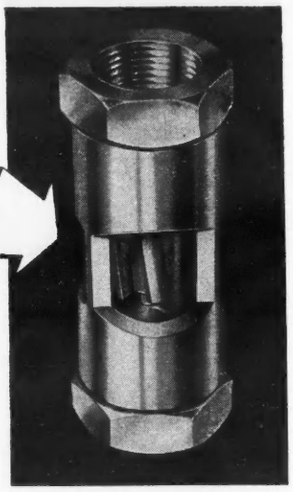

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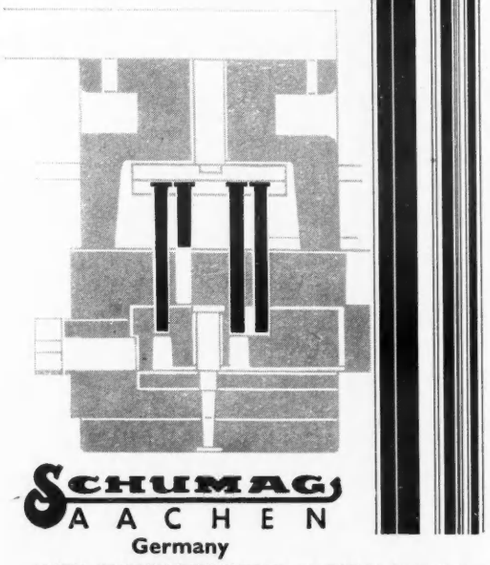

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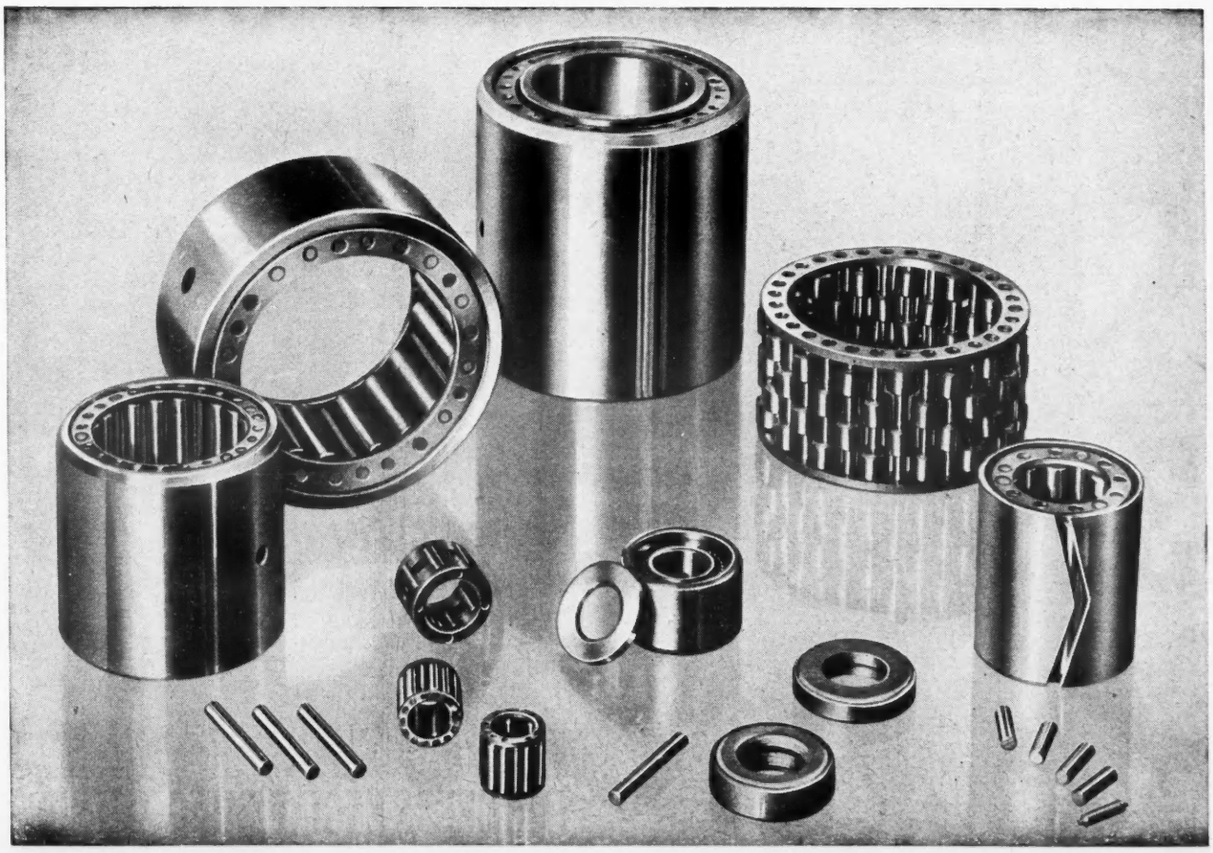

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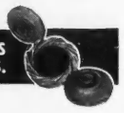

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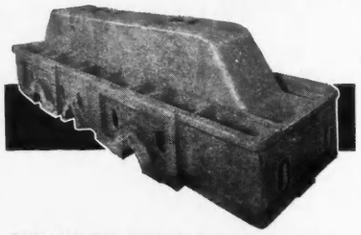

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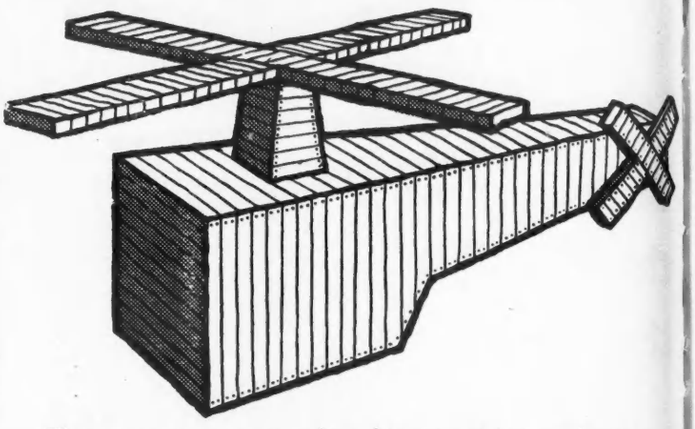

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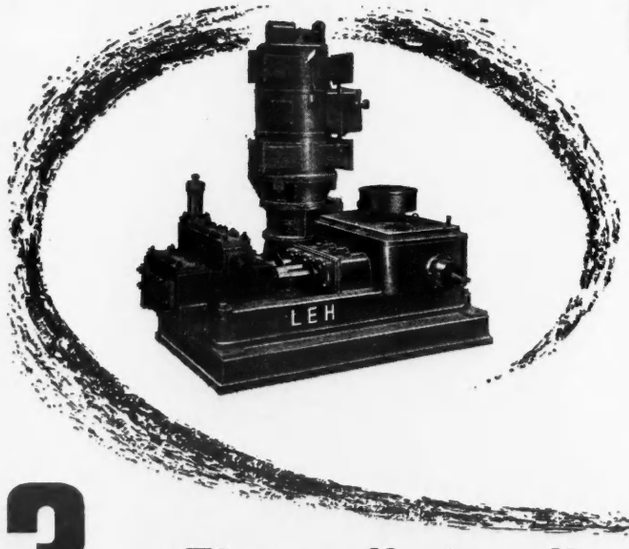

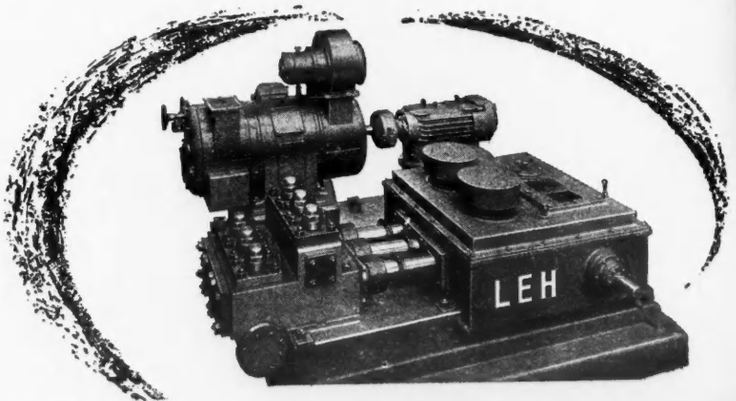

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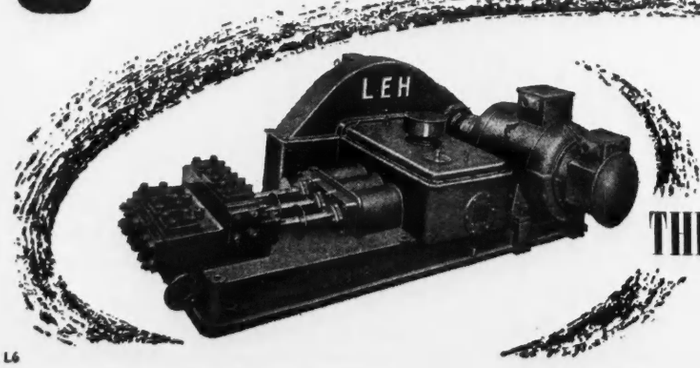

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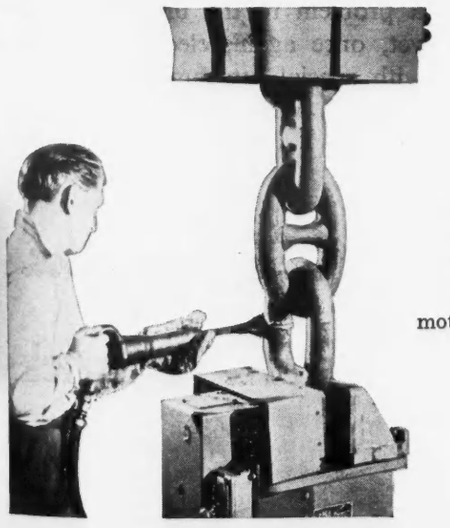

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THE ENGINEER

No. 5455 AUGUST 12, 1960 Vol. 210

B.O.A.C. AND SUPERSONICS

Last week Sir Matthew Slattery, the recently appointed chairman of the British Overseas Airways Corporation, delivered himself of certain thoughts about the provision of supersonic aircraft for the Corporation. The idea of building such craft must unquestionably excite designers and the conditions to be met set research workers some intriguing problems to solve. But Sir Matthew was principally concerned to illuminate the policy to be pursued by the Corporation rather than to discuss technicalities. With barely a week's chairmanship behind him he has already concluded that competition amongst airlines plus a readiness amongst prospective passengers to regard the reduction of journey time as a very substantial advantage will make it necessary within a decade to introduce supersonic craft on, at least, Atlantic routes, almost regardless of costs. He declared forthrightly that he did not intend that B.O.A.C. should find itself behind in the race to obtain supersonic craft. But he made it clear that in his view the airlines of the world would be acting sensibly if all were to agree not to introduce supersonic transports without giving ten years' notice, on the ground, presumably, that so major a change in aircraft speeds would render subsonic equipment prematurely out of date and thereby complicate finance even more severely than the introduction of jet transports has done in the present period. If there were no such agreement — he thought it unlikely it could be reached—B.O.A.C. must take part in the race to obtain supersonic aircraft, which meant it must have such craft by 1968.

But however exciting the design of supersonic aircraft may seem, economically the situation is not very inviting either for airlines or prospective manufacturers. Sir Matthew rightly felt that much more detailed work than has so far been done will be needed before financial figures with any pretence to full reliability can be offered; and it occurs to us that, at least until a reasonably full specification for a suitable aircraft has been agreed, detailed figures will not be available upon which to base estimates. But taking into account the probably high seating capacity of a suitable aircraft, its very large daily carrying capacity consequent upon its high speed permitting it to complete more journeys in a given time than a subsonic craft, and operating costs estimated to be up to 50 per cent higher than those of present airliners, it does not seem likely that very many supersonic airliners will be needed to satisfy the whole demand of the world. Indeed, Sir Matthew felt that any British maker would be unlikely to sell more than 25. Allowing a cost of £50 to £60 millions for research and development, so that each aircraft sold would have to carry about £2 million, the price of a supersonic airliner might be about £5 millions, which on a ten year life basis yields a rather alarming rate of depreciation of £500,000 per annum. If, however, 100 or more could be sold the difference in cost to an operator for each ton-mile might amount to fourpence, an amount which might make supersonic costs similar to ruling subsonic costs. No doubt it was with that thought in mind that Sir Matthew favoured co-operation between the British and American industries in the production of a single design. But one cannot help thinking the Americans would be likely to turn down such a suggestion as their industry is believed to be well in advance of the British industry in its understanding of supersonic problems, has craft such as the Mach. 1.8 "Hustler" already in the air, and is far advanced with the detailed engineering of the B70 "Valkyrie" cruising at supersonic speeds. By contrast, in Britain the Bristol 188, a supersonic research aircraft, has yet to be become airborne. Of course, supersonic experience, militarily, is being gained with English Electric F1 and T4 aircraft, a single seat fighter and trainer respectively, capable of Mach. 2 or more. Alternatively Sir Matthew may think Governmental support possible, because there must surely be military value in a supersonic transport aircraft. If so the Government might become responsible for a substantial part of the cost of research and development.

We judge from Sir Matthew's remarks that he intends to see that B.O.A.C. is equipped with supersonic aircraft, at best before all others, at worst not seriously later than any competitor; and that if British industry cannot supply suitable craft in time the Corporation will purchase from America. Obviously, however, he would prefer a British design. Obviously too, there is going to be some energetic pressure applied to the industry and to the Ministry of Aviation in the hope of getting suitable craft made in Britain. He remarked that the first thing to get done was to get out a brief specification giving size, range, cruising speed etc., upon which the industry could bite to carry design further. In about a year's time he envisaged that the results could be examined and if found reasonable a beginning could be made in the building of prototypes. For its part B.O.A.C. could issue such a specification within a matter of weeks; but it would be for the Government to decide which of the recently formed manufacturing groups should take on the work. It may be, of course, that not every one of those which might build such a craft will feel equally willing to take on the work. What the industry will want to know is the extent to which the Corporation or the Government will be prepared to invest in research and development, bearing in mind the quite substantial risk that in the end the Corporation may find its needs better met by American (or even perhaps French or Russian) aircraft. That risk will be reduced the sooner decisions are made about financing research and about really getting down to the job. For even supposing a basically satisfactory design to have been reached commercial success will depend upon the ability to reduce turn-round times and upon the incidence of unscheduled maintenance, not to speak of hard-won and necessarily slowly won experience of what happens to tyres, hydraulic systems, windows (if any!) and other components when soaked for substantial periods at high temperatures, etc. It may even be that the earlier supersonic aircraft to go into service will in fact take fewer prizes than later designs from which certain "bugs" have been removed. One need feel only momentary dismay that the Corporation in promising every possible support

(whatever that may mean) added the qualification, short of any economic commitment for aircraft. After all the Corporation canot be expected to order an aircraft for which at present not even a specification exists, let alone any reliable estimates of operational costs!

MONNOW MUSINGS

Returning from holiday a week or two ago we happened to meet over lunch an angler who had just been fishing on the River Monnow, a charming little river which flows from the Black Mountains on the Welsh Border to the town of Monmouth where it joins the River Wye. He was puzzled. He had fished the river for years; and during those years the inevitable changes, such as the fall of a tree here and the under-cutting of the bank there had been slow and slight. But latterly the river, quite suddenly apparently, had, he said, started to undercut its banks really seriously, depriving farmers literally of acres of land every time the river comes up in flood. Why, he asked, should there be this sudden change of regime? Now anglers, though ill-named as liars, may possibly be inclined to embroider an account rather more than other men; so, we confess, we took little real notice. But, as so often happens, confirmation came along within a matter of days through the publication in an illustrated contemporary of an article about the Monnow complete with pictures which demonstrated pretty conclusively the truthfulness of our angling acquaintance. The local farmers, it seems, tend to lay the blame on the drainage authority, which has lately been active in clearing the bed of the river of obstructions to flow and which has also felled a number of river-side trees. The drainage authority, however, holds that the erosion of banks has been due not to any of its activities but to unusually heavy floods during the winter. There exists, in fact, the kind of dispute which often occurs between riparian owners, anglers, and other river users on the one hand and drainage authorities on the other. Far be it from us to attempt to say which is right in the present instance!

But we do suspect that British rivers all of which are small and tame by the standards of continental regions will tolerate for a time and rectify gently interferences with their regimes which elsewhere would invite disastrous consequences; and that as a result many of those whose concerns or interests lie in running water may have a rather limited understanding of the possible consequences of any action taken and even of the innate destructive power of a river.

Certain reflections occur to us from our own observations of the regimes of rivers and the work of drainage and other authorities. Many of those authorities — that for the Monnow is probably one— are particularly concerned to prevent flooding, or if flooding cannot be altogether prevented at least to reduce the depth of flooding and the length of time for which any given flood lasts. Now in parts of the world where great rivers are liable to generate catastrophic floods only one method of flood control has proved at all fully effective. It is that of building dams and creating reservoirs high in the catchment area in which some of the flood waters can be stored and from which it can be later released when the high flow lower down the river has subsided. In fact, the flood flow is spread by these means over a greater number of days than it would have lasted had there been no reservoirs and its height is thus reduced. By a curious contrast, in this country an almost directly opposite policy seems to be pursued by some authorities. It consists of removing all impediments to flow not only low down a river's course, which may be sensible enough, but in the upland regions too! True, upland flooding may thus be abated. But necessarily the rate of flow downstream must be increased even though as a consequence of clearance of impediments in the lower reaches the length of time during which flooding persists may be less prolonged. It is conceivable—it is the farmers' contention— that it is just such a greater rate of flood flow which is generating the damage on the Monnow. Another practice we have seen adopted is sometimes open to criticism too, unless carried out with discretion and with a proper understanding of a river's regime. It is the practice of dredging along substantial lengths of a river, no doubt with the object of enlarging the cross-sectional area above the river bottom and within the banks and thereby improving the ability of the river to pass flood water without overflowing. A point, of course, to be borne in mind is that in any river transporting silt there is a minimum speed of flow below which silt will be deposited, a point very well appreciated by engineers called upon to build irrigation canals but apparently less well appreciated here. Dredging mud out of a river already silted merely increases the rate at which silt will collect at times of normal flow; with the result that the mud banks can be built up to their original level often within a few months, a level sufficiently high to reduce the cross-sectional area and so to increase the speed of flow until it exceeds once more that critical for silt deposition so that a stable condition is reached. Selective dredging can prove much less costly. We know of a place, for example, where the removal of a bank of hard gravel has lowered water levels and raised the speed of flow for a distance upstream of a mile or so, causing mud banks to be eroded. The improvement is likely to be permanent.

Sometimes when we see dredging or some other activity being pressed forward along a river we wonder why there should be such an urge to prevent flooding. Many rivers, at places, have natural flood plains consisting of rough pasture which would actually benefit from flooding; and flooding in such a place may very well help to reduce flood levels lower down, owing to its reservoir effect. We sometimes suspect, no doubt unjustly, that drainage authorities undertake dredging and clearance in the higher reaches of a river under the mistaken belief that it helps to reduce floods when in reality such work was done during the war for the very different purpose of lowering the water table and so permitting crops to be grown on what was formerly marshy ground. By a kind of conservation of momentum the work continues to be done despite the fact that the land concerned has reverted to rough pasture which would benefit from a higher water table and recurrent flooding. Looking to the future when substantially larger supplies of water are likely to be in demand the time must surely come when drainage authorities which hurry floodwaters down to the sea, unused, will be adversely criticised. Indeed such criticism, often it seems to us well justified, is already becoming common.

RAILWAY FREIGHT IMPASSE

A forecast made last week that the coming winter may see delays in the distribution of coal by rail brings back to mind a situation which is not so much a "crisis", as it has been called in some quarters, as an ever present problem. The British Transport Commission has confirmed that difficulties are foreseen in the movement of freight traffic in general, particularly through the Midlands junctions. Serious shortages of "key" personnel are

said to exist, particularly in Birmingham and the surrounding area, and in the London district. The reason appears to be that in these parts of the country, in particular, there are concentrations of industries and firms able to offer much more attractive rates of pay than are open to the railways. This situation has already been recognised in the report of the Guillebaud Committee, and the staff stated to be in particularly short supply — shunters, guards and footplate men — are included in the groups which the committee considered to merit special treatment within the rationalised railway wages structure which it has proposed. It is impossible to foresee how effective such inducements will be in retaining and attracting staff, and how long any particular relationship with rates of pay elsewhere in industry will be preserved. In the meantime the railways are making commendable efforts in their various staff publications to stimulate pride and interest in the job and to give an overall picture of the progress of modernisation in its many forms. It is inevitable that on so extensive and complex a system the visible signs of modernisation should be somewhat thinly spread and that to many workers not directly concerned with the operation and maintenance of new motive power, conditions should seem to be but little changed from what they were before the plan was announced in 1955.

In connection with the persistence of the staff problem and its effects, it may be recalled that earlier this year cancellations of some excursion services and suburban trains running on main lines were necessary to make up a backlog in the movement of essential freight traffic. If such difficulties continue, diversion of traffic to other forms of transport appears inevitable and the railways may find it difficult to maintain the increased carryings of general merchandise which they recorded in 1959, and their slightly larger share in the total carryings of coal, attributed in the 1959 report to the recovery of some large flows of short-hauled traffic previously carried by road. The seriousness of the outlook is underlined by the comment in the same report that "it became fairly certain in 1959 that the carriage of coal will remain at a lower level for some time to come." In spite of this it has been necessary to urge that as much coal as possible should be moved between now and Christmas in anticipation of 1961 requirements in case severe weather in the early part should bring suddenly increased demands. Concentration of marshalling in new mechanised yards is no doubt relieving the situation in some areas by cutting out short inter-yard workings and the staff required to operate them, but the British Transport Commission may well be having second thoughts to-day on its comment in its 1956 report on "the fundamental paradox of having at the same time overcrowded roads and an apparatus of public transport which could carry greater traffics."

INDUSTRIAL HEALTH

One of Mr. Edward Heath's final tasks as Minister of Labour was the pleasant one of announcing, in Parliament, that the Trustees of the Nuffield Foundation had decided to allocate £250,000 to the further development of group industrial health and hygiene services in this country. The money, the Minister said, would be used to assist practical schemes which promised to be self-supporting after an initial period of development. Health and hygiene are matters which have an important bearing on industrial productivity and the attention which has been given to those matters in recent years has proved to be well worth while. It is sometimes suggested, in fact, that the high standard of this country's industrial health and hygiene services leaves but little room for improvement. Certainly, the legal requirements for safeguarding the health of industrial workers, as laid down by the Factories Acts, are kept under constant scrutiny so that, when necessary, they can be expanded. Furthermore, many industrial firms voluntarily provide medical and nursing services which are a valuable asset both to the firms and their employees. Then, too, there are group schemes, like those at Slough and Harlow, for the provision of industrial health services in those areas. The progress of both these schemes has been referred to in these columns at different times. Employers pay annual subscriptions towards the maintenance and operation of the industrial health centres which have been established in those towns. An indication of the usefulness of such schemes is given by the fact that, last year, the membership at Slough was 193 firms with 17,638 employees, while at Harlow there were forty-four industrial firms with 7455 employees as members, in addition to nine building and civil engineering firms. The prompt attention given to ailments and injuries which might otherwise be ignored or neglected results in the saving of many man-hours. Undoubtedly, the toll of industrial disease and injury is much less serious than it used to be. But all who are working in the field of industrial health and hygiene are in no wise complacent about the degree of success achieved. More research, for example, into toxic substances in factory atmospheres and into other hazards in the working environments is still essential. There is scope for more chemical, physical and biological tests to discover how best such hazards can be eliminated, especially when new materials and new manufacturing processes are taken into account. This new allocation by the Nuffield Foundation will stimulate work of this nature. It is work that is bound to help industry.

The Engineer—100 Years Ago (AUGUST 10, 1860)

"VICTORIA STATION AND PIMLICO RAILWAY"

"The works on this station and railway are rapidly approaching completion. Although the line is only about one mile and a quarter in length, it consists of numerous works of art, some of them of considerable magnitude, particularly as compared with the length of the line. The Victoria station is situated at the end of Victoria-street, about a quarter of a mile from Buckingham Palace. The ground upon which the temporary station buildings are now being rapidly erected was formerly occupied by the basin of the Grosvenor Canal and covers about ten and a quarter acres. This space is divided in the centre, one-half being appropriated to the London, Brighton and South Coast Railway Company, and the other half to the London, Chatham and Dover and the Great Western Railway Companies jointly, and for which purpose the mixed gauge has been laid, not only on this portion of the station, but over the main line."

"The chief work on the line is the bridge over the Thames, and this, from its peculiar construction and the rapidity with which the works have been executed, deserves some notice. This bridge, which carries the railway over the river, including the land openings, extends 920ft in length, and consists of two stone abutments at each side of the river and three piers in the river, supporting four arched spans of 175ft each. There are two land openings of 70ft span, one at each end of the bridge, carrying the railway at a height of 16ft over the roads on to the bridge over the Thames. The height above Trinity high water to the under side of each arch is 22ft, and to the springing of each arch 4ft 6in, making the rise of the arch 17ft 6in, or one-tenth of the span."

"On the 9th of June, 1859, the first stone was laid on the north pier. Since that time the works progressed regularly and with great rapidity, with the exception of about seven weeks in the autumn of 1859, when operations were almost entirely suspended in consequence of the strike among the men. The erection of the ironwork of the arches was begun on the 28th of February last, and the bridge is now completed."

Some Notable Locomotives of 1910

By E. C. POULTNEY, O.B.E.

WHEN reviewing locomotive practice on British Railways reflected by designs introduced during the year 1910, half a century ago, several examples present themselves as being worthy of notice, and, of these, possibly the most prominent were found on the London and North Western, for which line C. J. Bowen-Cooke produced at Crewe his express passenger engine "George the Fifth," the first of a highly successful locomotive class noteworthy as being the first to be fitted with a superheater on this railway.

The appearance of these engines and their outstanding performance with heavy passenger trains attracted a large amount of attention ; in fact, as O. S. Nock remarked when referring to them in *The Railway Magazine* of February, 1937, they "marked the beginning of a new era on the North Western."

Coincidently, with the completion of "George the Fifth," No. 2663, a further example of the same 4–4–0 type emerged from the Crewe Works, No. 2664, "Queen Mary," identical in all respects except that it had 19in in place of 20in by 26in cylinders and was not superheated. Later in the same year a new powerful 4–6–2 tank engine appeared, designed for general service but more especially intended for suburban passenger traffic. Referring briefly to other events of moment in 1910, H. A. Ivatt at Doncaster proceeded further with the fitting of superheaters by turning out a superheated version of his large "Atlantic" locomotives of the "251" class after having in the year previously, 1909, similarly fitted one of his smaller "990" class "Atlantics." At Darlington, V. L. Raven (later Sir Vincent Raven), having assumed the office of Locomotive Superintendent of the North Eastern in succession to W. Worsdell, built his first three-cylinder locomotive, a powerful tank design of the 4–6–2 type for mineral traffic and for shunting duties.

At Swindon, G. J. Churchward also built a large tank engine having the 2–8–0 wheel arrangement, intended mainly for coal traffic in South Wales.

For the Caledonian, J. F. McIntosh designed and built at St. Rollox a 4–4–0 passenger engine, distinguished by being the first locomotive to be fitted with a superheater in Scotland.

Following on the successful performance in passenger service on the Brighton line obtained with the superheater 4–4–2 type tank engines introduced in 1908, D. E. Marsh completed in 1910 an enlarged version in the form of a 4–6–2 side tank engine, No. 325, "Abergavenny," illustrated by a diagram, Fig. 10. In respect to the cylinder dimensions and the size of the coupled wheels, the new engine was like the former 4–4–2 design, but the boiler was considerably larger with a total heating surface of 1943 square feet, compared with 1202 square feet for the earlier class. The foregoing notes briefly outline what are thought to represent the principal locomotive developments seen on British railways during 1910, which will now be considered in greater detail. Before doing so, however, as the locomotives claiming attention are largely distinguished by being equipped with the flue tube superheater at that time being introduced more or less experimentally, it may not be out of place to make a few remarks concerning the fitting of the superheater and the use of highly superheated steam in locomotive service.

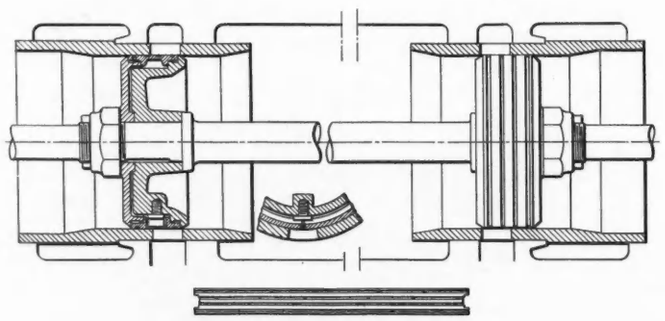

Fig. 1—Simple type piston valve, Schmidt's patent

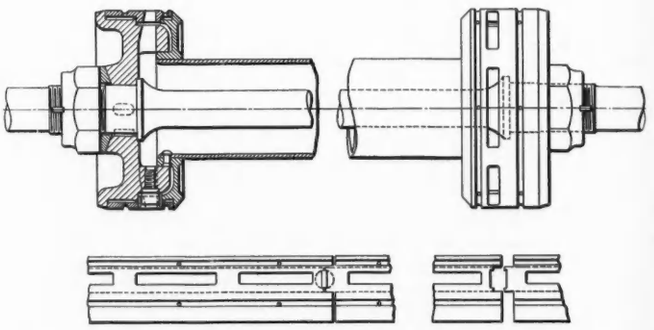

Fig. 2—"Trick" type piston valve, Schmidt's patent

The Schmidt Flue Tube Superheater

Over the years since the first examples of the Schmidt high-temperature superheater were introduced, large and important improvements have been made in the design and manufacture of this important adjunct to the steam locomotive. It may, therefore, be of some interest to refer to earlier practice, since this review of developments fifty years ago is associated with early examples of the application of the superheater having the superheater tubes positioned in the tubular system of the locomotive boiler. Placed in this position, a certain amount of apprehension was felt as to how the small tubes carrying the steam from the boiler to the cylinders would stand up to the high temperatures of the gases flowing through the enlarged smoke tubes in which they were housed, not only when the steam was passing through them, but also, and in fact more particularly, when steam was "Shut Off" and the locomotive either "coasting" with the regulator closed or when the engine was standing. Other points taken into consideration when dry superheated steam was supplied to the cylinders involved the design of piston-rod packing, piston valves and, what was most important, cylinder and valve lubrication. So far as practice on British lines was concerned, these all presented uncharted fields to be explored.

To provide for the protection of the superheater elements, an arrangement of dampers fitted to the smokebox was introduced by the Schmidt Superheater Company, automatically controlled to open when the regulator was opened and the locomotive running with steam "On" and steam, therefore, flowing through the superheater, while, on the other hand, when steam was "Shut Off," the dampers closed automatically to prevent the hot gases from flowing through the tubes, so preventing the element tubes from becoming overheated. This damper arrangement, usually automatic in action, was actuated by a piston in a small steam cylinder receiving steam from the steam pipe to the locomotive cylinders. With steam "On," the damper actuating piston moved to open the dampers and, when "Shut Off," the dampers closed under the influence of a suitably proportioned counterweight and connecting gear.

Considering now the piston valves recommended for use with superheated steam in place of slide valves, two different types due to Schmidt Superheater Company were introduced. These were two different designs, one known as the simple type and another of the "Trick" type.

The Marsh superheated locomotives on the London, Brighton and South Coast Railway were fitted with the simple type, as was also the case on the Midland Railway, while, on the other hand, Ivatt's superheater locomotives had valves of the "Trick" pattern, as had also Bowen-Cooke's locomotives. Generally, piston valves arranged to give inside admission were favoured largely because valve spindle stuffing-boxes and packing were avoided. Here again, however, variations were to be found in the practice followed on different railways, a notable example being R. M. Deeley's Midland superheated locomotives of the "900" class 4–4–0 type when converted to use superheated steam.

Piston Valves and Piston-Rod Stuffing-Boxes

The two patterns of piston valves designed by Dr. Schmidt recommended for use with high-temperature superheated steam are shown by Figs. 1 and 2. The former is the simple type, having a wide ring, the special feature of which was the provision made whereby the steam pressures on the inner and outer surfaces were equalised, with the result that it was only pressed against the annular valve bushing with a force equal to its own tension, which was sufficient to give the required steam tightness.

In order to obtain a good fit for the packing rings in the valve heads, the end caps

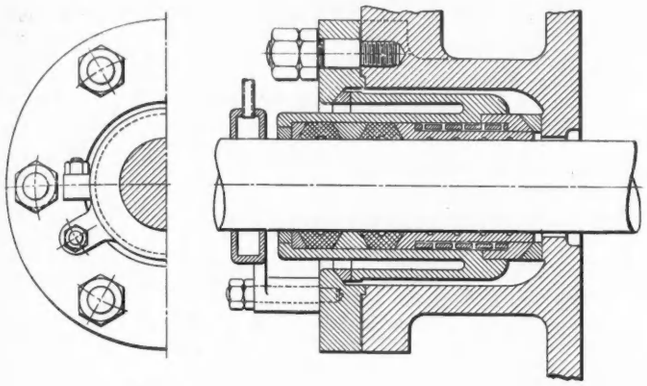

Fig. 3—Air-cooled stuffing-box and packing, Schmidt's patent

are designed to have a certain amount of elasticity so that when in place and screwed up against the valve heads at the centre, the outer periphery will be pressed against the packing rings by the steam pressure, but at the same time allowing of sufficient expansion so that they can spring outwards to secure steam tightness against the valve bushing. The drawing shows the valve as for "outside" admission. For "inside" admission, the heads would be put on the valve spindles in the reverse position so that the resilient end caps would be between the valve heads —not outside, as shown.

The other valve (Fig. 2), illustrates the "Trick" ported design, having a trick channel extending between the two valve heads, as shown. The claim made for this type of valve was that the double admission feature enabled a smaller diameter valve to be used compared with the wide ring simple type for a given size of cylinder.

The special form of piston-rod stuffing-box with the metallic type of packing designed for high-temperature superheated steam is illustrated by Fig. 3. The special feature of this design was the arrangement made for air cooling of the part containing the special rod packing, which was designed so that, when in place, it was surrounded by air, thus being aircooled—considered to be of importance. It will also be noted that the part containing the packing was held in position between two spherical surfaces, one inner and one outer, so making provision for any angular movement of the piston-rod.

Mention may also be made of another fitting which came into use. This was extended piston-rods, not by any means new in locomotive practice, but one which gained favour partly on account of the larger cylinders and, in consequence, heavier pistons commonly used with superheated steam which, it was thought, required the additional support thus provided, and at the same time it was considered that cylinder lubrication would be more effective. Extended rods (tail rods) were taken up more on some railways than others. Their value has always been a debatable point, and in any case depends largely on the proper maintenance of the bushes in the cylinder cover fittings. For cylinder and valve lubrication, mechanical lubricators came into use and have been very successful, so much so that they are largely used up to the present day.

"George the Fifth" and "Queen Mary" Locomotives

One of the main inspirations prompting the building of the engine "George the Fifth" (Fig. 4) fitted with the Schmidt superheater is commonly thought to have been the outstandingly good results given by the Marsh 4–4–2 passenger tank locomotive on the Brighton line, introduced in 1908 and illustrated in the 1958 article of this series. The attention of the North Western authorities to the working of these Brighton engines was brought about by their use when running between Brighton and Willesden with the "Sunny South" express, a through service between the London and North Western and Brighton.

The Brighton engines ran through to Willesden where they were changed, the North Western engines then taking over for the northward journey, the reverse procedure being, of course, followed in the case of the service operating in the opposite direction. Ultimately, during the summer of 1909, an arrangement was made whereby this service was worked on alternate days throughout between Rugby and Brighton by a North Western engine of the "Precursor" class, No. 7, "Titan," and one of the Marsh superheater tank engines, No. 23. The task, therefore, set the Brighton locomotive was to make the run of 90·5 miles from East Croydon to Rugby with a train of some 240 tons, seven coaches, timed to run the 77·2 miles between Willesden Junction and Rugby at a mean speed of 52·6 m.p.h., and in the southbound direction at 53·9 m.p.h.; further, as the Brighton locomotives were not fitted with water pick up apparatus, the rather limited tank capacity of 2110 gallons had to suffice for the whole distance of 90·5 miles from East Croydon to Rugby, thereby indicating a water consumption of not more than about 23 gallons per mile.

The new superheater 4–4–0 type locomotives, illustrated by the accompanying photograph of No. 2663, "George the Fifth," in general design were virtually a modification of the "Precursor" type of 1904, introduced by G. Whale, from which the new engines differed principally by the fitting of a twenty-four element Schmidt superheater and the substitution of cylinders with Schmidt pattern "Trick" ported piston valves 8in diameter in place of semi-balanced slide valves used for the earlier engines. The boilers for the superheater engines were identical with those used for the "Precursor" class and carried the same working pressures, but the inclusion of the superheater involved a re-arrangement of the tubes and, therefore, modified the distribution of the evaporative heating surfaces.

The cylinders, as used for the first few locomotives built, had a diameter of 20in with a stroke of 26in. Later engines were, however, given rather larger cylinders, 20½in diameter. In all cases the pistons were mounted on rods extended to pass through the front cylinder covers.

The valve gear standardised by G. Whale for all his designs was Joy's and this was retained and, in order to suit the piston valves giving "inside" admission, rocking levers were interposed between the valve gear and the valve spindles in order to reverse the direction of movement while retaining the gear as standard for the slide valve engines. For the purpose of carrying the rockers, they were arranged to work between two brackets fitted with suitable bearings, one being fitted on each of the upper bars of the four bar crosshead slide block guides.

The valve travel in "full gear" was 5 3/16in, comparing with 5in for the "Precursor" class. The design of the cylinders was entirely in line with modern standards, having short straight ports positioned at the extreme ends of the barrels, and automatic air valves were fitted on the steam chests communicating with the steam space between the valve heads.

For cylinder and valve lubrication, a mechanical lubricator was fitted. The motion details in general followed prevailing Crewe standards, embracing built-up crank axles with balanced crank webs and hollow-bored crank pins, together with the standard arrangement of central floating bearing carried in a casting bolted to a frame stretcher in front of the firebox and at the front end to the motion plate. This casting also carried a centre bearing giving added support for the component comprising the curved slides for the die blocks of the Joy valve gear. These new 4–4–0 engines had smaller bogie wheels than those used for the "Precursor" and "Experiment" class express locomotives, the diameter being reduced to 3ft 3in, comparing with 3ft 9in. The Schmidt superheater provided a heating surface of 302·5 square feet, made up of twenty-four sets of elements housed in an equal number of flues 5in outside diameter. The small tubes numbered 168, 1⅞in diameter outside, and the length between the tube plates measured 12ft 2¼in. The superheater damper gear control, contrary to more usual practice, was operated by an arrangement consisting of a hand lever fitted with a trigger and working in notched sector plates,

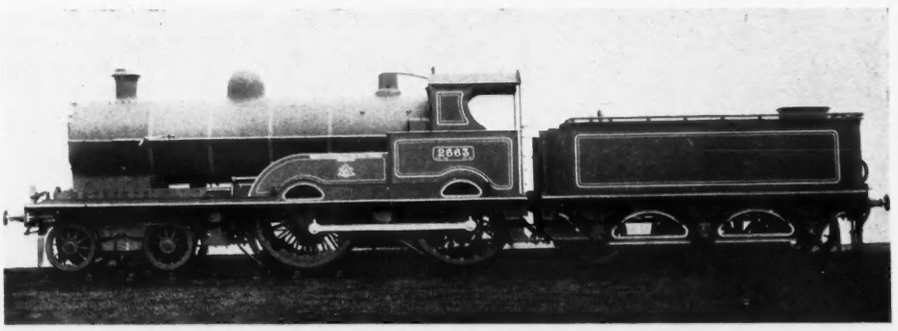

Fig. 4—C. J. Bowen Cooke's superheated locomotive, "George the Fifth"

thus allowing variations in the amount of opening given to the dampers. This control was fitted to the cab on the driver's side, and the rod passing forward along the boiler barrel to the smokebox was fitted with a coil spring to counteract the weight of the dampers.

In all important respects the "Queen Mary" locomotives, of which ten were built, resembled the "George the Fifth" class except that the piston valve cylinders were 19in diameter with a stroke of 26in and they were not superheated. They are generally reported to have been an improvement on the "Precursor" class, which might be due to the improved cylinder design. The first engine, No. 2664, "Queen Mary," is illustrated by the photograph reproduced in Fig. 5.

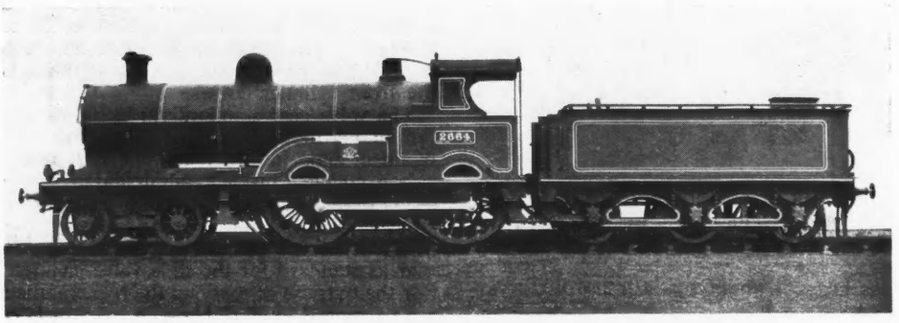

Fig. 5—The locomotive "Queen Mary," non-superheated

The principal dimensions of the "George the Fifth" and the "Queen Mary" are as below :

"George the Fifth," 4–4–0 Locomotive, No. 2663

Cylinders :	
Diameter and stroke, inches	20 by 26
Driving wheels :	
Diameter, inches	81
Heating surfaces, square feet :	
Tubes and flues	1,385·40
Firebox	161·75
Total evaporative	1,547·15
Superheater	302·5
Combined	1,849·65
Grate area, square feet	22·4
Steam pressure, pounds per square inch	175
Engine weight, tons :	
On drivers	38·25
Total	95·85
Engine and tender	99·1
Rated tractive force, pounds	19,075
Rated tractive force, pounds 20½in cylinders	20,062

"Queen Mary," 4–4–0 Locomotive, No. 2664

Cylinders :	
Diameter and stroke, inches	19 by 26
Driving wheels :	
Diameter, inches	81
Heating surfaces, square feet :	
Tubes	1,800·5
Firebox	161·5
Total	1,962·0
Grate area, square feet	22·4
Steam pressure, pounds per square inch	185
Engine weight, tons :	
On drivers	38·1
Total	59·2
Engine and tender	98·45
Rated tractive force, pounds	18,222

From the foregoing particulars it will have been noted that the superheater engines with the larger 20in cylinders had a steam pressure of 175 lb per square inch compared with 185 lb per square inch for the 19in engines.

The original "Precursor" class had a steam pressure of 175 lb per square inch when first built ; later, the writer believes, raised to 180 lb per square inch. With respect to the boiler heating surfaces, the particulars given for the "Queen Mary" class correspond in this respect to the later engines of the "Precursor" class, which had 301 tubes compared with 309 when originally built. In other respects, so far as design and general dimensions are concerned, all these boilers were as first designed in 1904.

"George the Fifth," Engine No. 2663. Dynamometer Car Trial, July, 1910.—Shortly after the completion in July, 1910, this engine ran a trial trip from Crewe to London (Euston) and return on July 24. Full particulars were given in THE ENGINEER at the time, from which the undermentioned information has been taken. During each journey, a large number of indicator diagrams were taken and a continuous record of the tractive effort exerted at the tender drawbar. For test purposes, a train of thirteen eight-wheeled passenger coaches was assembled, weighing 322·78 tons, making with the dynamometer car of 34·7 tons, a total weight behind the tender of 357·48 tons.

On the "Up" journey from Crewe to London, the time for the run to Rugby was 84·25 min. for the 75·5 miles, representing an average speed of 53·75 m.p.h., and the following 82·6 miles to London were covered in 85·25 min., start to stop, equal to a mean speed of 58·25 m.p.h. Thus, the average running time speed came out at 56 m.p.h. Returning on the same day, the "Down" journey of 158·1 miles to Crewe was accomplished non-stop in 156·5 min., meaning an average speed of 60·5 m.p.h.

Estimating from the particulars given by THE ENGINEER, the mean power developed during the "Up" journey was 936 i.h.p. and for the faster "Down" run, 1082 i.h.p. Horsepower characteristics plotted by the writer indicate that on the high speed "Down" journey the mean powers developed at speeds of 40 to about 77 m.p.h. ranged between just over 1000 to 1100 i.h.p., obtained at 60 m.p.h. The maximum reached at about the same speed was about 1220 i.h.p. According to a statement made at a later date by C. J. Bowen-Cooke, the coal consumption on the slower "Up" journey averaged 39·6 lb per mile, and for the fast "Down" journey, 45·7 lb per mile.

Coal Consumption Comparison with the Non-Superheated "Precursor" Class.—Though not perhaps very conclusive, it may be of interest to recall some figures officially given of the coal consumption of the "Precursor" class. These particulars were given by C. J. Bowen-Cooke and cover running between London and Crewe with heavy main line passenger trains. For the "Precursor" class, the results apply for a total of 34,348 miles of running when the average gross load (engine and train) was 433·75 tons, average speeds 52 m.p.h. and the mean consumption 0·131 lb of coal per gross ton-mile. According to the figures given for "George the Fifth" at 56 m.p.h., the corresponding coal rate was 0·087 lb per gross ton-mile for a single journey from Crewe to London with an intermediate stop at Rugby.

L.N.W.R. 4–6–2 TANK ENGINES

The engines now under notice (Fig. 6), are the first six-coupled tank engines of an entirely new design to be built at Crewe for the L.N.W.R. and are further distinguished as being the first Crewe engines to have a boiler of the Belpaire type.

L.N.W.R. 4–6–2 Tank Locomotives

Saturated Steam	
Cylinders :	
Diameter and stroke, inches	18½ by 26
Driving wheels :	
Diameter, inches	68½
Heating surfaces, square feet :	
Tubes	1,338
Firebox	137
Total	1,475
Grate area, square feet	23·9
Steam pressure, pounds per square inch	175
Engine weight, tons :	
On drivers	44·5
Total engine	78·0
Rated tractive force, pounds	19,360
Superheated Steam	
Cylinders :	
Diameter and stroke, inches	20 by 26
Heating surfaces, square feet :	
Tubes and flues	947·4
Firebox	138·0
Evaporative total	1,085·4
Superheater	248·2
Combined	1,333·6
Grate area, square feet	23·9
Engine weight, tons :	
On drivers	44·0
Total engine	77·0
Rated tractive force, pounds	22,600
Tank capacity, all engines, gallons	1,700

It is, of course, true that six-coupled tank engines had been built previously but they could not really be called new designs for the reason that they constituted tank engine versions of previous tender engine classes, such as the Crewe "coal" engines and the "18in" goods class. On the other hand, Bowen-Cooke's 4–6–2 was entirely new. In

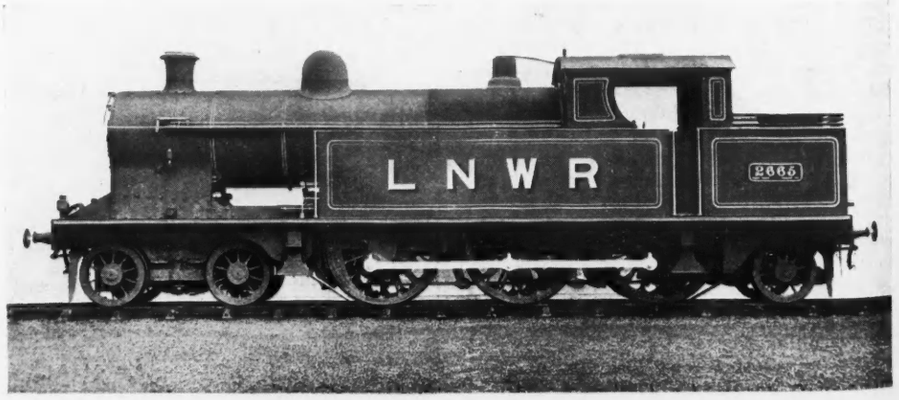

Fig. 6—Bowen Cooke's 4–6–2 tank engines for the L.N.W.R.

general, these new engines assimilated standard Crewe practice, involving Joy's valve gear and other well-known features. The driving wheels, with a diameter of 5ft 8in. made them suitable for main line requirements as well as for heavy suburban passenger services, and they also proved useful for assisting main line trains over Shap, for which purpose some of them were stabled at Tebay. The leading dimensions of these useful engines as built originally without superheaters and also as later modified with superheaters are tabulated above.

The Great Northern Locomotives

The important development in locomotive practice on the Great Northern in 1910 was the fitting of superheaters to the large "Atlantics" of the "251" class first turned out of the Doncaster shops in 1902. Before, however, describing this innovation, it may be proper to mention that in 1909 one of the original "Atlantics" of the "990" class No. 988, first introduced, it may be mentioned, in 1898, had been modified to include a Schmidt superheater having twenty-four sets of elements and at the same time was given a new pair of cylinders with piston valves of the Schmidt "Trick" pattern arranged for inside admission. This superheater conversion followed the initial venture in the use of the superheater undertaken in 1908, when one of the standard eight-coupled 0–8–0 freight engines, No. 417, became the first Doncaster design to use superheated steam.

When the "Atlantic" type passenger engine was rebuilt with a superheater, a new pair of cylinders with Schmidt pattern "Trick" ported valves giving inside admission was also fitted. The new cylinders were 20in by 24in, comparing with 18½in by 24in, the original standard size for both the smaller "990" class and also for the larger wide firebox "Atlantics" built in the first instance in 1902. All the "Atlantics" had Stephenson's valve gear driving direct semi-balanced open-backed slide valves providing a direct and free exhaust. With the adoption of the superheater and piston valves giving an inside admission and the retention of a direct drive for the valves, modifications became necessary to the valve gear to give an "inside" in place of "outside" admission required for the slide valves and at the same time retain the existing reversing gear connections. The valve gear alterations required involved altering the positions of the fore gear and back gear eccentrics on the crank axle in relation to their respective cranks so that the centres of the fore gear eccentrics were positioned behind the cranks in the direction of rotation by an amount equal to 90 deg. less the angle of advance and the centres of the back gear eccentrics fixed ahead of the cranks by an equal amount. In order to retain the existing reversing control gear which, in line with normal practice, lowered the expansion links for forward running and raised them when reversing for backwards running, the fore gear eccentric rods were connected to the top of the expansion links and the back gear rods to the lower end of the links, thus giving crossed rods when the cranks were on their outer centres.

The valuable feature of increasing lead openings for admission at reduced rates of "cut off" given by Stephenson's valve gear was, however, retained. It may perhaps here be recalled that the same arrangement of Stephenson's valve gear was standardised for all Churchward's standard engines of the two-cylinder type which have outside cylinders, though, in this case, the valve gear between the frames operated the valves positioned above the outside cylinders through a pair of rocking levers, both arms of which were, however, on the same side of the rocking shaft, so that there was no reversal of motion for the valve spindles, thus giving the equivalent to a direct drive, the rocking levers in this case being only fitted for the purpose of transferring the drive from the inside valve gear to the valve spindles outside the frames.

Returning now to the engine No. 988, the following are the official leading dimensions when rebuilt with a twenty-four element superheater :

G.N.R. "Atlantic" Type Locomotive No. 988

Cylinders :	
Diameter and stroke, inches	20 by 24
Driving wheels :	
Diameter, inches	80
Heating surfaces, square feet :	
Tubes and flues	1,027
Firebox	137
Total evaporative	1,164
Superheater	242
Combined	1,406
Grate area, square feet	24·5
Steam pressure, pounds per square inch	170
Engine weight, tons :	
On drivers	32·2
Total engine	60·0
Engine and tender	103·1
Rated tractive force, pounds	17,340

The larger "251" class "Atlantics" were, in the first instance, fitted with twenty-four sets of superheating elements, but later the superheating surfaces were increased by the fitting of thirty-two sets of elements.

The first of the "251" class engines to be superheated, No. 1452, built at Doncaster in 1910, is illustrated by the accompanying engraving (Fig. 7), and the undermentioned are particulars of the leading dimensions :

G.N.R. "Atlantic" Passenger Locomotive No. 1452

Cylinders :	
Diameter and stroke, inches	20 by 24
Driving wheels :	
Diameter, inches	80
Heating surfaces, square feet :	
Tubes and flues	1,882
Firebox	140
Total evaporative	2,022
Superheater	427
Combined	2,449
Grate area, square feet	31
Steam pressure, pounds per square inch	170
Engine weight, tons :	
On drivers	36
Total	69·4
Engine and tender	112·5
Rated tractive force, pounds	17,340

Twin Tube Superheater

While the standard superheater fitted to the "Atlantic" type engines of the larger "251" class was of the Schmidt flue tube type, a further design of superheater appears to have been tried. This was a Doncaster design, known as the Gresley Twin Tube Superheater.

As applied to the wide firebox boilers, it comprised forty-two 4in diameter flue tubes and twenty-one sets of 1¼in inside diameter superheating elements. Each of the elements made a double pass in two adjacent flues one above the other. There were two headers, one in the top of the smokebox receiving saturated steam from the boiler, from which the steam was conducted by the elements to a lower header having connections to the cylinders. The disposition of the heating surfaces for the large boilers was as follows :

Tubes (2in diameter), square feet	1,305
Flues (4in diameter), square feet	703
Firebox, square feet	141
Total evaporative, square feet	2,149
Superheater, square feet	410
Combined, square feet	2,559

In the case of the boilers fitted with the larger thirty-two element superheater, the small tubes were reduced in size from 2¼in outside diameter to 2in, which for the length between tube plates of 15ft 11¾in would give a better length to bore ratio of 104 to 1 compared with 91·5 to 1 with the 2¼in tubes.

Sectional general arrangement drawings of these "Atlantic" type locomotives fitted with the twenty-four element superheaters, Schmidt "Trick" pattern piston valves and extended piston-rods were published in THE ENGINEER of November 28, 1913. It may also be mentioned that the Stephenson valve gear, modified as described, was also very well illustrated.

Fig. 8—Raven's N.E.R. three-cylinder locomotive

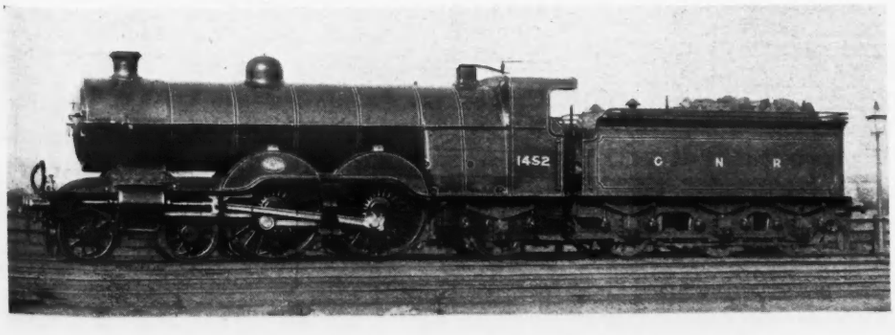

Fig. 7—H. A. Ivatt's superheater "Atlantic" No. 1452, Great Northern Railway

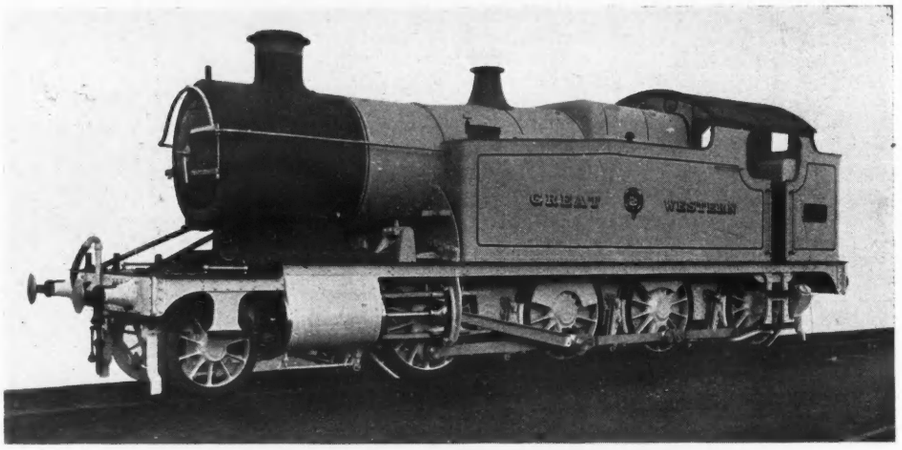

Fig. 9—Churchward's 2–8–0 tank engine for the G.W.R.

V. L. Raven's First Three-Cylinder Locomotives

Following the three-cylinder 4–8–0 side tank engines built for the North Eastern Railway at Gateshead to W. Worsdell's designs in 1909, discussed in the last of these articles in THE ENGINEER of November 27, 1959, a further three-cylinder design appeared in 1910, one of which is illustrated by engine No. 1113 (Fig. 8). Described as being a mineral locomotive, the 4–6–2 type tank engines, though intended for duties of a not particularly spectacular kind, are, nevertheless, historically important as being the first example of many three-cylinder locomotives built in accordance with the requirements of V. L. Raven, later Sir Vincent Raven, for the North Eastern. Moreover, in the arrangement of the cylinders and in the method of arranging the drive to the coupled wheels, initiated by this first example, the three-cylinder type remained Raven's standard practice for all the numerous classes of engines subsequently built. In fact, there was but one exception and this differed only with respect to the single-throw crank axle, which was the second in place of the leading axle, the design in question being Raven's three-cylinder 0–8–0 heavy freight engines first built in 1920.

The standard cylinder arrangement and the method of arranging the drive to the coupled wheels involved placing the three cylinders in line, two outside and one inside the frames under the smokebox. The drive from each cylinder was taken by the leading pair of wheels, for which purpose a single-throw crank axle was provided for the centre cylinder. Stephenson's valve gear, standard for all locomotives, was used, three sets between the engine frames with all six eccentrics mounted on the single-throw crank axle.

This arrangement of drive and the valve gear called for some clever designing by the drawing-office and was, of course, only made possible by the use of a single-throw crank axle. The arrangement looked somewhat complex, though not more so than the two inside Walschaerts valve gears as applied to the Swindon four-cylinder engines. For the boilers designed for these three-cylinder engines, a large diameter barrel of 5ft 6in was used, in itself a notable feature, first adopted for the "Atlantics" of 1903 and again for the enlarged 4–4–0 passenger engines built in 1909. Other features of these new tank engines were 16½in by 26in cylinders, which, together with 55½in drivers and steam at 180 lb per square inch pressure, gave a maximum tractive force of 29,300 lb, thus fitting them for handling heavy mineral traffic, for which they were specifically designed and which formed such a large proportion of North Eastern freight traffic.

In all, twenty of these engines were built at Darlington and, when first put into traffic, used saturated steam, but later were fitted with superheaters. The undermentioned tabulated particulars apply to the engines as originally built and when later superheated.

The particulars given for the engines after being fitted with superheaters are those given by Sir N. Gresley, Institution of Mechanical Engineers, 1925, "The Three-Cylinder High-Pressure Locomotive."

N.E.R. 4–6–2 Three-Cylinder Engines

Saturated Steam

Cylinders :	
Diameter and stroke, inches	16½ by 26
Driving wheels :	
Diameter, inches	55½
Heating surfaces, square feet :	
Tubes	1,508
Firebox	140
Total	1,648
Grate area, square feet	23
Steam pressure, pounds per square inch ...	180
Engine weight, tons :	
On driving wheels	55·6
Total	87·9
Rated tractive force, pounds	29,300
Tank capacity, gallons	2,300
Coal space, tons	5

Superheated Steam

Heating surfaces, square feet :	
Tubes and flues	681
Firebox	141
Total evaporative	822
Superheater	258·3
Combined	1,080·3
Steam pressure, pounds per square inch ...	160
Engine weight, tons :	
On driving wheels	55·5
Total	87·5

Other dimensions as for saturated steam.

G. J. Churchward's Eight-Coupled Tank Engines

The Great Western eight-coupled tank engines of the 2–8–0 wheel classification (Fig. 9), built at Swindon in 1910, were, like the N.E.R. locomotives, intended for working heavy coal traffic, principally in South Wales. In general, these locomotives resembled those of the 2–8–0 type just built for main freight services in 1903, the cylinders and coupled wheels being identical in dimensions, namely, 18½in by 30in and 55½in.

With these dimensions and steam at 200 lb per square inch working pressure the tractive force, maximum, was 33,170 lb. Like the 2–8–0 tender engines of 1903, these tank engines were one of the original standard designs as first contemplated and in all the principal details followed the standards laid down for the two-cylinder types, having outside cylinders combined with half saddles to support the smokebox, incorporating integral exhaust passages. This is one of

G.W.R. 2–8–0 Tank Engines

Cylinders :	
Diameter and stroke, inches	18½ by 30
Driving wheels :	
Diameter, inches	55½
Heating surfaces, square feet :	
Tubes and flues	1,349·64
Firebox	128·72
Total evaporative	1,478·36
Superheater	191·79
Combined	1,670·15
Grate area, square feet	20·56
Steam pressure, pounds per square inch ...	200
Engine weight, tons :	
On driving wheels	72·5
Total engine	82·1
Rated tractive force, pounds	33,170
Tank capacity, gallons	2,300

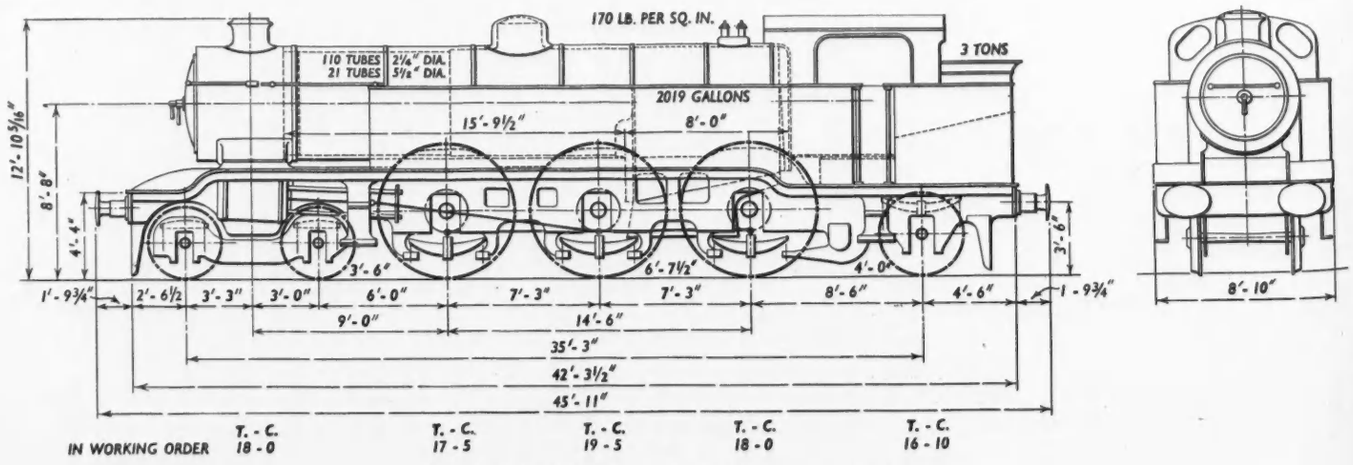

Fig. 10—The Marsh tank engine "Abergavenny," L.B.S.C.R.

the excellent features of Churchward's practice, offering advantages which have escaped general recognition. These engines, known as the " 4200 " class, were numbered 4200–4299 and 5200–5254, and comply with the above dimensions.

The particulars given apply to engines fitted with the Swindon No. 3 superheater fitted in fourteen 5⅛in flue tubes.

L.B.S.C.R. Locomotive No. 325, " Abergavenny "

Following the success attending the introduction of his 4–4–2 type passenger tank engines in 1908, D. E. Marsh designed at Brighton an enlarged version in the form of a 4–6–2 side tank engine, also, like his earlier 4–4–2 engines, fitted with a Schmidt superheater. Though this locomotive is of some importance as being the forerunner of others of this general type introduced later on the Brighton line and elsewhere, strange to say, an official photograph of " Abergavenny " does not appear to exist. However, a diagram drawing, furnished by the Southern Region, B.R., reproduced in Fig. 10, gives a good idea of this locomotive, which was originally numbered 325, at one time carried by one of W. Stroudley's celebrated engines of the " Grosvenor ' class and with the old number also took the name " Abergavenny " of the old engine. In respect to the cylinders and coupled wheels, this engine was exactly like the 4–4–2 superheater engines of 1908, but the steam pressure was higher at 170 lb per square inch comparing with 160 lb.

The leading dimensions of this locomotive were as follows :

L.B.S.C.R. 4–6–2 Engine " Abergavenny "

Cylinders :	
Diameter and stroke, inches	21 by 26
Driving wheels :	
Diameter, inches...	79½
Heating surfaces, square feet :	
Tubes and flues	1,462
Firebox...	124
Total evaporative	1,586
Superheater	357
Combined	1,943
Grate area	25·16
Steam pressure, pounds per square inch ...	170
Engine weight, tons :	
On drivers	54·5
Total engine...	89·0
Rated tractive force, pounds...	20,800
Total tank capacity, gallons	2,232

The drawing shows the engine slightly modified with boiler mountings reduced in height and " Pop " safety valves in place of those of the Ramsbottom type.

The Caledonian Superheater Locomotive

The concluding example, though by no means the least important locomotive development of 1910, is the 4–4–0 type express passenger engine No. 139, turned out of the St. Rollox Works of the Caledonian Railway, notable on account of the interesting fact that it was the first in Scotland to have a superheater. At the time this engine was built, five new engines of the successful " 140 " class were on order, and opportunity was taken to redesign the last of these, No. 139, and fit a modified boiler having a twenty-four element superheater. The appearance of a superheater-fitted example of the well-known and highly successful " 140 " class, first built in 1904, is of note, because it coincided with the completion of the North Western superheater locomotive " George the Fifth " at Crewe, thus inaugurating superheater-fitted motive power for the West Coast joint passenger services operating between London and Glasgow, Edinburgh and the far north. In order to accommodate the Schmidt pattern superheater and other attendant modifications, the engine illustrated by the photograph reproduced in Fig. 11 was modified by having a longer smokebox to accommodate the superheater header, which, in turn, required a lengthening of the main frames at the front end.

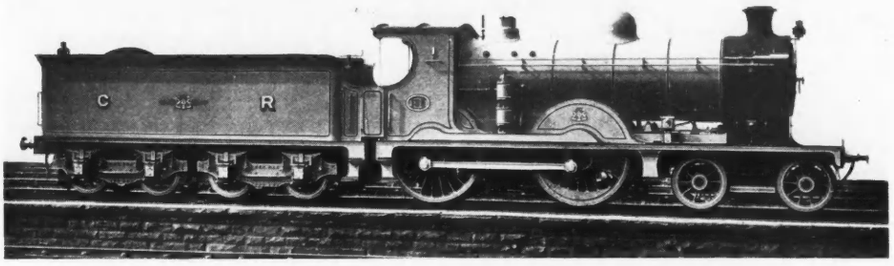

Fig. 11—Caledonian superheater passenger engine No. 139, J. F. McIntosh

The boiler, of the same sizes as for the standard " 140 " class, was modified with respect to the disposition of the heating surfaces by fitting a twenty-four element superheater having a heating surface of 330 square feet. McIntosh also reduced the working steam pressure of 180 lb to 165 lb per square inch but, in line with approved practice when superheated steam was substituted for saturated, larger cylinders were fitted and the tractive effort was maintained substantially as before. In this case the new cylinders were 20in by 26in as against the original size of 19in by 26in. They had Schmidt type " Trick " piston valves above the cylinders, operated by the standard Stephenson valve gear through the medium of rocking levers to suit the valves, which were arranged for " inside " admission. Other special features included extended piston-rods, automatic air valves connecting with the steam chests, mechanical lubrication for the valves and pistons and a rather elaborate automatically-operated damper control gear, which, while preserving the automatic opening feature according to whether the engine was running with steam " On " or " Off " or standing, made it possible to regulate the amount of damper opening. For this purpose a handwheel in the cab was provided along with an indicator plate and pointer showing the damper opening.

Locomotives of the " 140 " class had large eight-wheeled double tenders, which were again used for the superheater version, but with slightly modified bogies with independent bearing springs in place of compensated spring gear.

The leading dimensions of these fine engines are given as under :

C.R. Passenger Engine No. 139

Cylinders :	
Diameter and stroke, inches	20 by 26
Driving wheels :	
Diameter, inches	78
Heating surfaces, square feet :	
Tubes and flues	1,220
Firebox...	145
Total evaporative	1,365
Superheater	330
Combined	1,695
Grate area, square feet	21
Steam pressure, pounds per square inch ...	165
Engine weight, tons :	
On drivers	38
Total Engine	59
Engine and tender	115
Rated tractive force, pounds	18,700

As on former occasions when preparing these contributions to The Engineer, reminiscent of locomotives introduced on British lines fifty years ago, the writer acknowledges with thanks the assistance received from many of his friends. In this instance, thanks are due to E. S. Cox, Assistant Chief Mechanical Engineer, B.T.C., London, and to other old friends, including B. Spencer, Doncaster, R. A. Smeddle, Chief Mechanical and Electrical Engineer, W.R., B.R., Swindon, and C. R. H. Simpson. The photograph of the C.R. 4–4–0 engine was supplied by the Scottish Region, B.R., and the Southern Region, B.R., furnished the drawing of " Abergavenny."

London Passenger Transport

In 1959 London Transport paid its way, meeting all operating costs and interest, and ending the year with a small surplus, according to a review issued to London Transport senior staff. The review " London Transport in 1959," points out, however, that the change in travel habits, which has become so marked in recent years, continued to affect public transport adversely. Buses, in particular, are suffering from the growing competition of private cars, motorcycles, scooters and mopeds. In 1959 London Transport's road services carried 2756 million passengers, or 11·6 per cent fewer than in 1957 (comparison with 1958 is not practicable, because of the bus strike which occurred in that year).

Increasing use of private vehicles not only reduces the number of passengers carried by the buses, but because of street congestion makes it more difficult to operate the scheduled services.

There is no single solution to the problem of public transport in London—indeed, it is not really a single problem at all—but the year 1959 was one in which significant developments were started which should result in some easement. In the period under review the three-year programme for replacement of trolleybuses by diesel engined vehicles was put in hand. Already a better co-ordination of services and the extension of certain routes beyond their former termini has been possible as a result of the change of vehicle. To replace the trolley vehicles " Routemaster " buses are being used, and these, despite their increased size and passenger capacity of sixty-four, use 5 per cent less fuel than a standard fifty-six seater London bus.

On the Underground system, work on the extension of electrification from Rickmansworth to Amersham and Chesham was well advanced and the second part of the Metropolitan Line improvement had been started. Modernisation of signalling was also in hand in the eastern area of the District Line, and, by the end of 1959, the first three trains of the new light alloy type had been put into service on the Piccadilly Line. Provision of car parks at surburban stations continued, and by the end of 1959 there was accommodation at several points for a total of 2900 cars.

Although Government approval for the proposed new tube railway—the Victoria Line—had not been received by the end of 1959, detailed planning continued and schemes for nine out of the thirteen stations were approved. Authority was also given for the construction of short experimental twin tunnels to test new designs for quicker and cheaper tunnel lining.

Nuclear Power Prospects in Australia

We reproduce below extracts from a recent address to the board of governors of the International Atomic Energy Agency, delivered by Mr. W. H. Spooner, Australian Minister of State for National Development. Outlining the power needs of Australia, Mr. Spooner expressed interest in the development of small reactors which could be used economically in remote areas where mineral deposits and the fuels for their smelting were sometimes situated 700 miles apart by rail. Mr. Spooner went on to discuss the scope and aims of atomic energy research in Australia.

AUSTRALIA has for some years been enjoying probably the most sustained and soundly based period of economic development in its history. Moreover, we have great anticipations of further development which we are confident we will transform into realisation.

Our area is 3,000,000 square miles and our population 10,000,000 persons. A small people in a big country. But since 1945 our population has increased by more than one-third due largely to our national immigration programme—net immigration to Australia in the last ten years has amounted to 2,000,000 people.

To make this development possible we have geared our activity to economic growth by encouraging investment both in private enterprise and in the public field. In twenty years we have doubled the number of our factories and of our factory workers. The total rated horsepower in our factories has increased fourfold. For each factory worker the rated horsepower of engines and motors in use has increased from an average of 2·4 h.p. to 4·4 h.p.

We need to continually expand our manufacturing industry because we aim at continued growth in our population and we look to industry to provide employment for the population growth. We are, however, still a nation that depends for its export income on primary industries, predominantly wool, but including wheat, flour, meat, butter and dried fruits. Primary products produce 80 per cent of our export income. Minerals are also important and account for nearly 10 per cent of our export income. Australia is the world's largest producer of lead and one of the largest producers of zinc. Other important minerals are gold, copper, coal and uranium. We have not yet discovered, much less developed, the full range of our mineral riches. Indeed, in quite recent years we have made notable discoveries of minerals—copper, bauxite, uranium, coal and iron—which will undoubtedly give further impetus to Australian development.

The limiting factor to Australian development is its lack of water. Its average annual rainfall is only 16½in compared to a world average of 26in. Of its total area of 3,000,000 square miles, 37 per cent has a rainfall of less than 10in per annum. I venture the opinion that the greatest good to Australia which could come from the use of atomic energy would be a process of converting salt-water into fresh-water at a cost low enough to permit the water to be used for irrigation.

The fact that overseas capital is coming into Australia at the rate of over £100 million per annum is most important to us, because there is so much to be done which cannot be encompassed from the finance available to us, within Australia.

The Place of Atomic Power in Australia

In this general setting of national development with its emphasis on manufacturing and improvement of transport facilities, the provision of rapidly increasing fuel and energy supplies is vital.

In ten years our total consumption of primary energy has increased (in terms of black coal equivalent) by over 50 per cent in total and *per capita* by 20 per cent. We have at present over 5,000,000kW of installed capacity in electric power stations and our output of electric power is increasing at an annual rate of about 9 per cent. In 1940 electrical energy accounted for only 2 per cent of the total energy used in Australia. To-day electrical energy in its different forms accounts for approximately 25 per cent of all energy used.

The use of petroleum products has also increased and accounts for over 30 per cent of energy used at the present time.

We are well placed to meet our future expansion of electric power. We have great resources of black coal in New South Wales and Queensland and of brown coal in Victoria. Improvements in coal-mining efficiency have resulted in lower costs of coal production. In 1953 the average cost of coal in one power system was 10·7 dollars per ton. It is now 7·8 dollars, and in new stations to be commissioned will be as low as 5·5 dollars per ton. The efficiency of thermal stations has also increased—in some cases by as much as 40 per cent per ton of coal. We are now able to export coal and expect to see our exports of coal go on increasing substantially in the coming years.

In addition, we have water resources in Tasmania, Victoria, New South Wales, and Queensland, that enable us to supplement our thermal supplies with hydro-electric energy. In Tasmania all electric power comes from hydro-electric stations. The Snowy Mountains Hydro-Electric Scheme—a great engineering project by world standards which is to cost an estimated £A374,000,000 (823 million dollars)—will, when completed, supply over 2,500,000kW of power and 5300 million kWh of peak load energy as well as diverting 1,800,000 acre feet of water from the fast running coastal Snowy River to the dry inland plains.

We have also in Australia six oil refineries which in 1959 after exporting more than 1,000,000 tons of products, provided over 85 per cent of Australia's requirements of refined petroleum products. The petroleum refining industry has developed rapidly during the last seven years. Its capacity has increased from 800,000 tons of crude oil a year to over 11,000,000 tons; and £A145,000,000 (319,000,000 dollars) has been invested in it. Plans are in hand for expansion of existing refining facilities and for the erection of three new refineries (two of which will produce high-grade lubricating oils). Allied with this industry there are plans for development of the petro-chemical industry involving projects costing £A40,000,000 (88,000,000 dollars).

All our crude oil is imported. Our imports bill for this is £A100 million (220 million dollars) f.o.b. This is the biggest item on our import bill and is about 12½ per cent of the total value of imports into Australia. Sea freight adds between £A30,000,000 and £A35,000,000 (66 and 77 million dollars).

Our great hope is we will before long discover petroleum in Australia itself. An intense search for oil is being conducted at the present time by private companies who are given financial and technical assistance by the Federal Government. About £A63,000,000 (139 million dollars) has already been spent on this search. There have been encouraging developments, but we have yet to strike oil in commercial quantities.

This is the competition that atomic energy has to face in Australia. In the main industrial centres it will be a matter of hard economics in very competitive conditions; nuclear power costs will need to be appreciably lower than they are at present before nuclear power will displace other forms of power in the industrial areas of Australia.

We have one problem peculiar to Australia and that is great distances and high transport costs. Let me illustrate this by saying that in the outback of Australia it is common for pastoral properties in some parts to be 12,000 square miles or more in size and so far from the coast that it takes ten or eleven months to walk cattle from some of the more remote properties to market. In some of these remote areas are large mineral deposits which are faced with the need to transport their ore 600 to 700 miles by rail to smelters, or to bring their coal the same distance to the mine in order to smelt at the mine.

The development of small reactors which could be used economically in these remote areas would be of very great importance to Australia.

Atomic Energy Research in Australia

Despite what I have said you are not to think that we take a pessimistic view of the future of nuclear power. Indeed, we are taking atomic energy research very seriously indeed. We have set up a major research establishment at Lucas Heights near Sydney and are pursuing an independent line of research on the high-temperature, gas-cooled (H.T.G.C.) reactor system. This system shows promise of development as a breeder reactor. Also our work to date suggests that the system could provide—at least in some areas—electric power at a cost below that of power from conventional sources.

A major portion of the Commission's effort is concentrated on beryllium and beryllium oxide H.T.G.C. systems with some work being carried out on graphite carbide systems. The emphasis of the programme is on basic technological problems rather than on the early construction of a reactor experiment. Fuel element technology studies in progress include material preparation, fabrication, compatibility and irradiation investigations. Other work in progress relates to chemical processing, reactor physics and engineering aspects of H.T.G.C. systems.

We already are producing uranium in considerable quantities. The aggregate output of our mines is about 1000 tons of uranium oxide a year.

Like other producers of uranium, we are concerned that the demand may be less than world supply in the coming few years. We have already considerable proved resources and the indications are that we may well have a lot more.

The Australian Government has not yet decided whether it will permit the export of uranium over and above the present long term contracts with the United Kingdom and U.S.A. We could become comparatively large consumers, particularly if a reactor was developed which was suitable for use by large scale mining concerns in the outback. We have, however, permitted export of some

sample quantities. I think you can at least regard Australia as a potential exporter to the rest of the world and therefore we are interested in your current consideration of the problems surrounding the evolution of a safeguards system.

I would remind you that in Australia we have developed a major research establishment. We want to use these results not only for the benefit of Australia itself but as a contribution to the development of other countries in our part of the world. I hope, therefore, that as time goes by we shall be able to work in co-operation with the Agency in making the benefits of our work available, particularly to our Asian neighbours.

Coldwater 600kV Experimental Line*

No. I

Within the next few years, the Hydro-Electric Power Commission of Ontario plans to develop a group of hydraulic sites in a remote section of the province. Incorporation of this generation into the system will require extra-high-voltage transmission, probably in the 460kV range. To provide design information for the e.h.v. transmission lines required, a high-voltage experimental station has been constructed. Known as the Coldwater e.h.v. Project, the installation comprises two three-phase bundled-conductor test lines, each about 2500ft long, operating at voltages up to 600kV phase-to-phase. Information from the Coldwater Project will be used to determine the radio interference and corona loss characteristics of particular bundled-conductor arrangements, and to verify analytical methods which have been devised for applying test data to a range of actual line designs.

IN preparation for the proposed future use of extra-high-voltage transmission, the Hydro-Electric Power Commission of Ontario has constructed a 600kV, three-phase, experimental transmission line near Coldwater, Ontario. Known as the Coldwater Project, this research facility was constructed during the spring of 1959 and is now in full operation. The primary purpose of the experiments to be carried out at Coldwater is to provide measurements of corona losses and radio interference from various sizes and arrangements of bundled conductors at extra high voltages. It is hoped that these data will permit considerable refinement of present methods of evaluating these characteristics for use in the design of the proposed e.h.v. transmission lines in Ontario.

With the completion of the St. Lawrence Power Project during 1959, greater emphasis will be placed on nuclear and conventional thermal-electric generation. However, there are a number of hydro sites in the more remote parts of the province which can be economically developed as low-load-factor plants. Preliminary investigations indicate that approximately 1200MW may be available from a group of hydraulic sites in the north-eastern part of the province near James Bay. The problem of incorporating this power into the existing system economically, which is expected to be solved with the use of extra-high-voltage transmission, has given rise to the field investigations to be conducted at Coldwater.

Work to date on system studies has indicated that a suitable voltage level for the transmission of this power to loads in Southern Ontario should be in the vicinity of 460kV. The ultimate transmission scheme may involve two circuits over a distance of 450 miles. Although it is generally agreed that bundled conductors are required on lines of this voltage class, there is a lack of full-scale three-phase test data on which to base precise designs for the optimum bundled conductor sizes and arrangements for this particular scheme. For this reason, the primary purpose of the experiments at Coldwater is to refine the methods of determining conductor sizes for these lines. The proposed timing of construction for this new e.h.v. transmission requires that a final selection of conductor size be made early in 1960. Under these conditions, the Coldwater Project is being carried out under some pressure of time in order that results from the initial series of tests may be used to advantage in the design of the first stage of these new transmission facilities.

Transmission Line Design Problems

General.—Of the various elements in the design of high-voltage transmission lines, the single most important determinant of the cost of the line is the conductor. Not only are conductors costly in themselves but they are the major influence in the cost of the towers. This is particularly true of lines at the extra-high-voltages where the larger conductors control a larger portion of the total cost of the transmission line. The most important problem, therefore, in obtaining an economic design for an extra-high-voltage transmission line is to select a conductor size and arrangement which will provide satisfactory operation with the minimum present worth of all costs including future losses.

The generation and transmission scheme presently being studied by the Commission is expected to be used largely for peaking. The resulting low load factor reduces the economic effect of I^2R losses in the selection of conductor size to the extent that, even with a four-conductor bundle, the most economic conductor size is small enough to involve surface voltage gradients somewhat in excess of the value which is considered a reasonable maximum from the standpoint of corona and radio interference. Although it is to our advantage to use the smallest conductor size permissible under these conditions, the knowledge presently available concerning these two factors does not permit the calculation of their effect on conductor selection with the precision which is warranted by their economic importance in the case of this particular long transmission line.

The first stage of line construction for this scheme involves a single circuit 460kV line approximately 230 miles long. This line may be operated initially for a brief period at 230kV. A second section of about 175 miles, perhaps extending to 220 miles, will be constructed immediately following the first. The second portion may be modified in design to operate as a double-circuit 230kV line for an extended period and to be converted eventually to single-circuit 460kV using the same conductors. Because of the short construction schedule, the problems of conductor selection and tower design must be solved for both sections prior to construction of the first.

It was estimated early in the studies that a reasonable allowance for accuracy in calculating conductor size based on present knowledge of corona and radio interference, could represent a variation in the total cost of these first two sections of line amounting to several millions of dollars. Because of the obvious advantage in eliminating this significant area of doubt, the Coldwater Project was initiated as a necessary preliminary step in the design of the transmission scheme. It will attempt to determine more precisely the effect of conductor size and spacing on radio interference and corona losses at the extra high voltages. It may also verify proposed design formulas which would have much broader application for future designs.

Radio Interference Levels.—Efforts have been made in many countries to relate tolerable levels of radio interference to the maximum conductor surface voltage gradients of transmission lines. The problem is complicated by several factors. For instance, the radio interference effects of transmission lines with equal values of maximum conductor surface gradients may differ considerably because of the different propagation characteristics produced by variations in conductor geometry. Furthermore, the (tolerable) level of radio interference is affected greatly by the strength of broadcast signals in the areas of interest.

Nevertheless, there appears to be at present a prevalent opinion that properly-constructed e.h.v. lines will have acceptable radio interference levels if the maximum conductor surface voltage gradient does not exceed 16kV to 17kV r.m.s. per centimetre. This opinion is derived from test data obtained from experimental lines, coupled with measurements on operating lines, and seems to be soundly based. As indicated earlier in this paper, however, the acceptance of a maximum value of 17kV per centimetre imposes an economic penalty upon the new transmission lines to be constructed in Ontario, so that closer study of the basis for this limit was deemed necessary. For this reason the available data from both experimental and operating lines were studied and certain field tests were undertaken.

It was found that the existing test data from short experimental lines are difficult to interpret accurately in terms of long-line performance. The difficulty arises from a number of factors. In short test spans, resonant conditions produce large variations in field strength along the line. In some cases the terminal impedances of the test lines have been variable with frequency in such a way as to produce complex standing-wave patterns difficult to relate to long-line quantities. Additional complications are encountered where single-phase operation has been employed in tests. Difficulties have been indicated by a number of investigators in relating the propagation characteristics of single-phase and three-phase lines. Also, single-phase test results are affected by conductor sag, unless special precautions are taken to cancel the effect of varying distance from the ground plane, and the high electric field strengths in the vicinity of the line are likely to produce extraneous noise from the auxiliary hardware and supports.

Problems were also encountered in determining the maximum practicable conductor surface gradient from measurements on

* Extracts from a paper presented by J. G. Cassan and N. J. McMurtrie (Hydro-Electric Power Commission of Ontario) at the Conférence Internationale des Grandes Réseaux Électriques à Haute Tension (C.I.G.R.E.), Paris, June, 1960.

existing lines. Available information indicated considerable differences in the performances of lines with approximately the same electrical and physical characteristics. Our own field tests showed some lines to be quieter than other lines operating at lower conductor voltage gradients. In these particular tests there was evidence that the difference in radio interference levels was attributable to differences in the effectiveness of the shielding of hardware and insulators, or to the lack of such shielding, rather than to the conductors themselves. This factor may account for some of the problems encountered in comparing lines using different methods of shielding, particularly since the cumulative effect of hardware noise on a long line is not well known. In designing the Coldwater test lines attempts have been made to avoid these problems in so far as possible. Many of the problems associated with single-phase testing have been eliminated by using three-phase test lines, with identical conductor arrangements in each phase position, energised by a three-phase power source.

Since it is not practical to overcome the difficulties of interpreting short-line rest results by increasing the line length, another approach was taken. Provided the terminal impedances of the test line are known functions of frequency, the frequency spectra of a short line can be predicted from travelling wave theory, and the resulting curves used to predict the performance of similar long lines. At Coldwater, therefore, special radio-frequency wave traps are employed at the supply end of each test line to provide a high terminal impedance throughout the desired range of radio frequencies. Frequency spectra will be determined at the midpoint of each line, and it is expected that the geometric mean values of the maxima and minima in the frequency range of interest will provide a good indication of the equivalent long-line performance. This method has been tested by making measurements on sections of an operating line and the results are promising.

Since it is the primary purpose of the Coldwater tests to determine the minimum permissible conductor size for the new e.h.v. lines, efforts have been made to eliminate noise from extraneous sources. Hardware and corona shield designs were evolved by means of laboratory tests of radio noise and visible corona, and similar tests were employed to verify the corona-free operation of the Langstab insulators used on the line structures, at the highest test voltage.

Thus it is hoped that by avoiding or minimising the effects of some of the major sources of uncertainty, the results of the Coldwater tests will yield an improved evaluation of the relationship between conductor surface voltage gradients and the radio interference levels of bundled conductor lines.

Corona Losses.—Preliminary design studies indicated that for the loads and distances involved it would be economically desirable to use three- or four-conductor bundles operating near the upper limit of conductor surface voltage gradient, as determined by radio interference levels. It seemed likely that for such a line design the economic worth of corona losses would be relatively important, requiring some refinement of the approximate loss values used in the initial studies. It proved to be extremely troublesome to find a method of interpreting available data, first to establish confidence in the data by assessing various test results on a comparable basis, and second to extrapolate the data to the desired conductor sizes and configurations.

Working from a basis partly theoretical and partly empirical, a formula was developed for calculating transmission line corona loss for any conductor geometry. This formula, the form of which is indicated in the next column proved to be useful in reconciling many of the superficial differences in the test data of various investigators. By this means, excellent agreement was obtained between the results of several laboratory and field tests on single and bundled conductors. The loss equation has also been indirectly useful in indicating the probable sources of error in some data which cannot be reconciled with other, ostensibly similar, information. For example closer study of the test conditions involved in some single-phase experiments showed that variations in conductor voltage gradient due to sag in the span would cause non-uniform losses along the span, distorting the loss curves.

It was thought also that disparities in some test data were probably attributable to inadequate corrections for line insulator losses. Frequently attempts to measure the loss of insulator strings have been made by diverting the leakage current from the insulator unit nearest the grounded end of the string. Since some of the loss current must flow to nearby grounded surfaces through the shunt capacitance from string to ground, this method of loss measurement is theoretically incorrect, and subsequent tests on long insulator strings indicated large errors, in the order of 50 per cent or more, under some conditions. The significance of such errors in a given test will, of course, depend upon the number and type of insulators used and upon conditions of weather and surface contamination, but it is a possible error which should not be neglected.

The corona loss formula given below did, however, check with a quantity of experimental data sufficient to justify its use in tentative loss evaluations. It was found for the weather conditions expected over the proposed line route that the average annual energy losses for four-conductor bundles with diameters of 1·0in and 0·9in operating at maximum voltages of 480kV to 500kV, would be 12,000 kWh per three-phase mile and 28,000kWh per three-phase mile. The corresponding maximum power losses at 480kV were found to be 25kW per three-phase mile and 49kW per three-phase mile. It was evident that for the line length involved, corona losses of such magnitudes could influence the selection of conductor size. It was not considered desirable to rely solely on these calculations for final designs, particularly since the few data available on the loss characteristics of three- and four-conductor bundles did not provide an adequate check on the loss formula over a sufficiently wide range of conditions.

Instrumentation has been provided at the Coldwater Project, therefore, as described later, to obtain corona loss measurements on three- and four-conductor bundles with at least two conductor sizes. The line insulators have been treated with silicone grease to minimise leakage losses, and a short insulator test bus has been provided, with special instrumentation to obtain reliable insulator loss measurements which can be applied as corrections to the values of total line loss.

It is hoped that the Coldwater test data on three- and four-conductor bundles, in conjunction with the corona loss equation, will provide an improved basis for calculating the corona losses of bundled-conductor lines, a matter of considerable importance where there appears to be an economic advantage in constructing long lines of minimum conductor cross section.

Conductor Arrangement, Spacing and Clearances.—It was noted above that the preliminary design studies favoured the use of three- or four-conductor bundles. A number of factors, both structural and electrical, were considered in arriving at this conclusion. Preliminary designs and cost studies were prepared for the transmission scheme assuming a number of different operating voltage levels. It became evident from these studies that, above 345kV, the most economic conductor size (that is, one which would minimise the present worth of all charges including future losses), would be small enough to involve surface voltage gradients in excess of 17kV r.m.s. per centimetre. Even if the conductor sizes were selected so as not to exceed voltage gradients of this value, the studies indicated a clear advantage in using a voltage higher than 345kV. Under these conditions, the principal line design problem is to find the optimum conductor size and arrangement which will not exceed a tolerable level of radio interference or produce excessive corona losses.

For various conductor arrangements with any given maximum value of surface voltage gradient, increasing the number of conductors per phase adds to the structural load on the towers because ice accumulation, based on a given radial thickness, increases with the number of conductors in the bundle. At the same time, however, both the conductor cost and the line reactance are reduced. The economic effect of these variations can be determined for any given set of circumstances. In the case of the proposed e.h.v. transmission for Ontario, the studies favoured a four-conductor bundle, and for this reason, a four-conductor bundle is being used on each of the two lines at Coldwater during the first series of tests. A certain amount of flexibility in the hardware will permit the removal and re-arrangement of conductors so that both two- and three-conductor bundles can also be tested.

For a given maximum value of conductor surface voltage gradient, there is also an economic relationship between conductor size and phase spacing, since wider phase spacing will increase the tower costs but at the same time will permit a smaller conductor size to be used. This relationship can be determined for any given set of economic conditions. There are two limitations, however, to the minimum phase spacing which can be used in a given transmission line. The first and more usual limitation is that produced by the insulator string length, the probable swing angle of the insulators, and the required air clearances between phases and from phase to structure. The

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The general form of the corona loss equation mentioned in the text is :

$$P_1 = Kfnr^2E^2{}_a \ln \frac{E_e}{E_0}$$

where

P_1 = corona loss per phase (kW/km) ;
K = conditional constant dependent upon weather and conductor surface conditions (km) ;
f = frequency, cycles per second ;
n = number of conductors per phase ;
r = conductor radius (cm) ;
E_a = average conductor surface voltage gradient (kV_1 RMS per centimetre) ;
E_e = effective surface voltage gradient (kV_1 RMS per centimetre) ;
E_0 = critical surface voltage gradient (kV_1 RMS per centimetre).

second limitation, of which considerably less is known at the extra high voltages, is the matter of clearances to permit live-line inspection and maintenance to be carried out in safety and without excessive discomfort to the lineman. Live-line maintenance is used extensively at present on 230kV lines in Ontario and it is intended to apply similar methods to the proposed e.h.v. lines if practical and economic. Since the required clearances for this purpose can be determined in a precise way only by experimentaion, one of the tasks at Coldwater is to determine the extent to which live-line maintenance techniques, tools, and suitable clearances at the extra-high-voltage will influence the requirements for the design of structures. Some work may also be done on the influence of live-line maintenance in the design of conductor hardware.

(*To be continued*)

Tug for Newhaven, M.V. "Meeching"

By G. W. TRIPP, O.B.E., F.C.G.I., M.I.C.E.

THE two Newhaven tugs, "Foremost" and "Tidworth," (Fig. 1) both conventional steamers, are being replaced by one powerful motor vessel named "Meeching," (Fig. 2) the old name of Newhaven. She embodies a number of interesting features so that a short description of her seems warranted. She is equipped for salvage and firefighting duties in addition to towing. The order was placed with Seawork, Ltd., but the vessel was built by their associates P. K. Harris and Sons, Ltd., being launched at Appledore, Devon on February 25.

The principal dimensions of "Meeching" are: length, overall, 96ft 6in, between perpendiculars, 88ft; breadth, moulded, 12ft; depth moulded amidships, 12ft; tonnage, 170 gross. The vessel is driven by three-bladed solid bronze propellers, these being twin screws, and the main engines are of Lister-Blackstone manufacture, driving the shafting through Modern Wheel Drive oil-operated reverse reduction gears, the gearbox ratio being 3 : 1. The machinery is controlled from the bridge. The engines are rated at 660 b.h.p. when operating at 750 r.p.m. A bollard pull of 14 tons is obtained when each engine is developing not more than 500 b.h.p. when operating at the continuously rated torque and reduced revolutions. This pull is obtained when the vessel is in seagoing trim and displacement, and in a free running condition a speed of 12 knots is obtained. Steering gear is of the hydro-electric type operating twin rudders, the steering control being by telemotor. The auxiliary machinery includes two Lister diesel engines each driving a 30kW generator, a compressor and a salvage pump. There is also a Lister diesel engine driving a 5kW generator for harbour use. Electrical supply is at 220V d.c. The vessel is fitted for salvage duties: the two salvage pumps are of Hamworthy manufacture and are self-priming centrifugal sets; each has an output of 220 tons per hour against a total head of 140ft, when running at 1500 r.p.m. The pumps are arranged to operate in parallel for salvage duties, and in series for firefighting, there being a Universal fire monitor located on the top of the wheelhouse working at a pressure of not less than 180ft with a delivery of 200 tons per hour.

As will be seen from the illustration "Meeching" has an unusual appearance not having the conventional funnel, the exhaust gases being carried up the after legs of the tripod mast, and dispersing to the air through louvres just before where they are jointed to the main leg.

Lifesaving appliances to conform to the requirements of the Ministry of Transport include one glass-fibre lifeboat, one twelve-man inflatable liferaft in glass-fibre container and one section of buoyant apparatus. Rocket line throwing apparatus is also carried.

Among navigational equipment may be mentioned wireless telegraphy, v.h.f. radio telephony, echo sounder, and radar. The twin screws, twin rudders, and bridge control should lead to maximum efficiency and manoeuvrability in this new and original vessel.

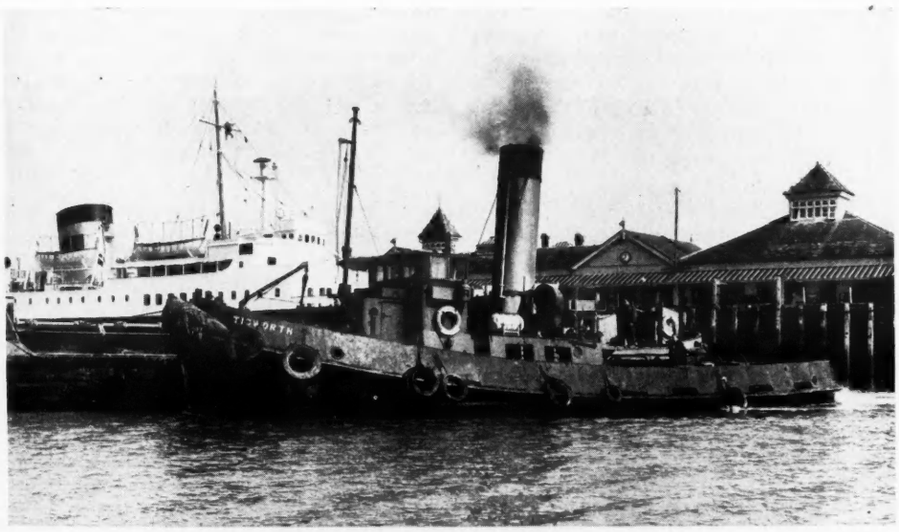


Fig. 1—"Tidworth," one of the tugs being replaced, at Newhaven harbour

Fig. 2—M.V. "Meeching"

Ship's Steel

THE additions and amendments to the "Rules and Regulations for the Construction and Classification of Steel Ships," recently issued by Lloyd's Register of Shipping, contain simplified requirements for ships' steel. In the new rules provision is made for the existing grades of steel to be replaced by five grades of which only three will be normally required. A table gives the specifications of the five grades, named A, B, C, D, and E and Grade A will be used for ordinary quality ship steel and Grade D for steel for welded construction, while Grade E is the equivalent of XNT steel. The remaining grades B and C may be accepted subject to consideration in individual applications, for example Grade C may be used instead of grade D provided it satisfies the impact test requirements. All grades have the same tensile requirement, 26/32 tons per square inch and an elongation of 22 per cent on a length given by the formula $L = 5 \cdot 65\sqrt{A}$ where A is the cross sectional area of the test piece. However, the controls in chemical composition, notch ductility become progressively more stringent with grade up to E. These simplified requirements, now incorporated in the rules, stem from the difficulties placed in the way of shipbuilders, steelmakers and owners by the differing requirements of the classification societies, in regard to hull structural steel, which called for twenty-two separate grades. It has long been felt that simplification was necessary and consultation between the seven major classification societies has resulted in agreement to reduce the twenty grades to the five announced in the modified rules.

LETTERS AND LITERATURE

Letters to the Editor

BRIDGE LAUNCHER OF LIGHT ALLOY

SIR,—The light-alloy bridge launcher, described in your issue of July 1, is certainly an ingenious apparatus.

But in its ingenuity there appears to be considerable complexity and unnecessary labour.

Why, I wonder, has somebody troubled to contrive and build this machine when there is already ample equipment available for the construction of bridges and flyovers with the utmost speed and economy ?

Lorry-mounted cranes, with lifting capacities of up to 50 tons and jibs up to 140ft long, can travel to a site, lift and place beams twice as big as those handled by the bridge launcher, and then go away. All the beams for the main span of a bridge or flyover can be placed in this way, in three or four days.

It is a waste of time to install impermanent equipment that must be dismantled as soon as its job is done when there is a much simpler way of doing the job.

A. A. GREENFIELD

Sheffield.
July 16, 1960.

SIR,—I am writing with reference to Mr. V. L. Holloway's letter which appeared in your issue for August 5. I would submit that the descriptive article referred to by Mr. Holloway is only applicable to a single span bridge of a closing span. Cranes can, of course, be used for a multi-span bridge, provided that crane access is possible below the bridge and that a sufficiently long jib can be fitted to the crane. Where, however, such access is denied, the case for using cranes is by no means so strong. The launcher, which was designed and fabricated by ourselves, is for use in such circumstances and, although it is fabricated as a special piece of equipment, it can readily be adapted for subsequent use.

I would point out that in the article submitted by Mr. Holloway, describing the placing of beams for the Bristow bridge, reference was made to a Bailey Bridge, presumably specially adapted, which was an essential part of the beam placing equipment. The launcher fulfils the role of the Bailey bridging unit and, in addition, completes the full operation, thereby obviating the need for any further lifting tackle. In conclusion I would like to point out that the design has been completed for a launcher able to place beams weighing 200 tons which, I feel sure, would prove competitive when compared with 100 tons mobile cranes, if such were available.

R. B. W. BOLLAND

Director and General Manager,
Head Wrightson Stockton Forge, Ltd.,
Stockton-on-Tees.
August 8, 1960.

PASSENGER TRANSPORT SERVICES COMPARED

SIR,—The article on Hamburg's traffic problems, which you published on June 10 (pages 991, 992) was particularly informative on that city's experience in the railed transport of passengers. Later in the month it was supplemented by some Chicago experience of the same sort revealed by Mr. F. Burggraf, Director U.S. Highway Research Board, in a lecture delivered in London ; and on June 24 you published a letter bearing on the subject from Mr. B. J. Prigmore—champion of trams. May I suggest that the matter can usefully be pursued with some comparison of the capacity and speed of the rival services.

To summarise briefly : Hamburg favours the use of the median strip, between the dual carriageways of a main highway, for the rail tracks of a tramway service.

In Chicago much the same layout has been adopted for the Congress Street Expressway ; though the rail service there is of trains that tend to justify the American term " rapid transit " in comparison with Hamburg's trams—if not in comparison with automobile transit on the adjacent carriageways. Since the route is a "freeway", barred to pedestrians, access to the stations is by means of bridges over the carriageways, or subways under them.

The either-way capacity of the Hamburg type of service, as postulated by Mr. Prigmore, is 20,000 passengers an hour, travelling in 250-seat tram-trains at forty-five second intervals. But Hamburg's experience is that, although trams may average some 12½ m.p.h. in the outer districts, a forty-five second interval becomes progressively harder to operate as the city centre is approached, and finally results in the speed dropping to some 5 m.p.h. Accordingly, Mr. Prigmore's passenger flow is a somewhat theoretical maximum—and slow.

Mr. Burggraf enables us to turn from theory to practice : he reported that the Congress Street Expressway entire carries 169,400 people a day, of whom 133,000 travel in motor vehicles and 36,400 ride in the trains. Of that total, 10·1 per cent (17,000 people) pass in the peak hour of the day, during which hour the proportion using the trains rises to 40 per cent (6800). Roundly and ignoring the small proportion of peak-hour traffic that is against the tide, one can say that the proven either-way capacity of the median rail service is some 7000 passengers an hour.

Leaving those figures for the present, may I now introduce a British postulate put forward by the Director of Road Research at the Urban Motorways Conference held by the Institution of Civil Engineers in 1956 ? Dr. (now Sir William) Glanville envisaged, as it were, the spare width of a motorway's formation not being laid with rails, but instead being paved, quite simply, to provide extra width of carriageway, so that one 12ft traffic lane in each direction might possibly be reserved for buses. He pictured one of those lanes in use, passing 1000 buses an hour at 40 m.p.h.; with forty-two-seat buses the passenger flow would be 42,000 an hour !

In the face of that figure I would revert to the previous ones only to draw attention to the fact that the maximum demand on one of Chicago's principal routes amounts to no more than 17,000 persons per hour. It is improbable that the demand on any single route in Britain would equal Sir William Glanville's 42,000 persons per hour ; his buses would seldom need to flow at more than a few hundred per lane per hour, and only rarely would it be justifiable to reserve a lane strictly for bus traffic. Accordingly, his idea seems on examination even more practical and practicable than he made it seem.

Sir William Glanville remarked that his idea " would seem to offer advantages well worth examining closely." That was in 1956 ; since when, in spite of an all-round deterioration in the conditions of commuter travel, nothing further has been heard—or, rather, been allowed to be heard—of the D.R.R's proposed solution. Sir, it makes one wonder whether, in this country, it is of any use anyone putting forward any idea running counter to the mythology that enshrouds the steel rail.

T. I. LLOYD

Guildford.
July 20, 1960.

Book Reviews

Theory of Mechanical Vibrations. By KIN N. TONG. John Wiley and Sons, New York. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 78s.

THIS is undoubtedly a textbook, and has arisen out of lecture courses given by Professor Tong at Syracuse University, New York State. The practising vibration engineer should benefit as well as the students by the logical manner in which the fundamental aspects are dealt with. The emphasis of the book is on theory, only a few practical problems being dealt with in detail, which after all is the correct approach for a textbook. Nearly any practical problem can be tackled if the theory has been fully understood.

The layout of the book is somewhat different from the usual. The fundamental principles are presented in a connected series of articles at the beginning of each chapter. Examples, applications and special topics relating to the previous theories are given in the second half of the chapters. An example of this division is the discussion of simple whirling of shafts in the theory section of Chapter 2, whereas the analysis of gyroscopic forces on flywheels during whirling and whirling due to hysteresis damping in the shaft is given in the application section. The book is therefore more suitable for " guided reading " or for use in a course where the lecturer decides which sections to take in a particular order and which to leave out. The chosen examples are relatively simple as it

has been assumed that the student has only a limited knowledge of elasticity. Familiarity with determinants and matrix algebra is, however, essential ; a useful appendix has been included on matrix algebra which should be studied before more than the first chapter is attempted. Professor Tong does not see this as a difficulty; to quote from the preface " little prior knowledge is required to understand this book, although some degree of maturity is indispensable."

Textbooks on vibration can often be judged by the manner in which simple harmonic motion is introduced. The reader is presented here straight away with the statement that it is a rectilinear motion of a point whose acceleration is proportional and opposite to its displacement. The usual case of a mass on a spring is taken to illustrate this motion, but the student who entertains the erroneous opinion that a gravity force term should be included in the equation of motion has only the following footnote to contend with : " according to the way we formulate this problem, the question whether or not there is a gravity force is irrelevant." This can hardly be of much help to him, particularly as this simple motion is immediately transposed into real and imaginary vectors in the next article.

The first chapter gives single degree of freedom theory and includes such useful topics as superposition theorems for external forces, equivalent viscous damping concept for both Coulomb and structural (hysteresis) damping and transmitted forces. Two degrees of freedom are discussed in the second chapter, the concept of normal modes being used extensively. That this book is not yet another " standard " textbook of the well established pattern is clear in the next chapter where the basis is laid in some detail for the solution of multi-degree of freedom problems by digital computer. The theory is presented on the basis of generalised co-ordinates and matrix algebra. Several methods for obtaining the eigen values of both damped and undamped systems are given in great detail. The final chapter deals with the free and forced vibration of elastic bodies, including a fairly detailed discussion on the othogonality of modes.

Each chapter has a number of exercises, but there are no answers given. The book is well produced with clear diagrams. The theoretical nature of the work has not led to many graphs or tables summarising particular aspects. The price of seventy-eight shillings would not nowadays be judged excessive for a textbook of this nature and of close on 350 pages. The index would appear to be adequate.

Concrete and Soil-Cement Roads. By W. P. Andrews, M.C., B.E., A.M.I.C.E., Hon.M. Inst.H.E. Contractor's Record, Ltd., Lennox House, Norfolk Street, Strand, London, W.C.2. Price 30s.

THIS is a very practical book wherein the author has succeeded in compiling, with a remarkable economy of space, a mine of information relating to the construction of concrete roads of all kinds and soil-cement base courses. The facts and principles are clearly stated and include most of the essential knowledge required by field engineers and contractors' agents concerned with these forms of construction and are evidently derived from sound practical experience. On almost every page the author has mentioned small, though by no means unimportant, details which are usually omitted from more academic textbooks and it is precisely these small points which may well have a decisive influence on the ultimate quality of the job. For instance, the site engineer is reminded that stockpiles of aggregates should be built up in horizontal layers and not in conical heaps, in order to avoid the inevitable segregation which will occur in the latter case. Is is also suggested that tests should not be confined to the compressive strength of the concrete, but should be applied to the reinforcing steel, dowel bars, joint fillers and sealers, and waterproof underlays, items which are so often taken for granted. Another small, though by no means trivial point, to which the author refers is the use of skips running on jubilee tracks, a procedure which should be avoided because the jars at the railjoints induce segregation both in aggregates and mixed concrete.

This emphasis on details is supplemented, throughout the book, by comparisons of British, Continental and American practice. Mention is made, for example, of the American practice of omitting expansion joints in concrete roads and forming dummy joints at intervals of 15ft to 30ft and the British practice of using up to 14 lb of mesh reinforcement per square yard is compared with Continental specifications in which an allowance of 10 lb per square yard is rarely exceeded, even on roads carrying heavy traffic. Mechanised construction is naturally discussed at some length and reference is made to the " Shavian " finisher which gave such an excellent running surface on the St. Albans By-pass, doubtless due, to a great extent, to the use of six two-wheeled bogies to support this machine on the running rails.

A short chapter is devoted to prestressed concrete roads and the experimental runway at Orly Airport is mentioned in which a slab thickness of only 6¼in is said to be equivalent to a thickness of 24in in a normal concrete slab. Prestressing would almost certainly enable much longer slabs to be laid without expansion joints and the constant state of compression would eliminate cracking, but, as the author remarks, much more research is necessary before this process is likely to become standard practice in large-scale road construction.

Further subjects dealt with are concrete roads for tank traffic, concrete farm roads, concrete roads on peat subsoils, cement-bound macadam and cement-grouted roads. In the latter case the author suggests that sand-cement grout may be made in an ordinary concrete mixer, but wisely adds that a special high-speed grout mixer is more satisfactory. The maintenance and repair of concrete roads is adequately covered and frost heave is discussed in this connection. Although this type of failure is rare in Great Britain, experience with small paved areas suggests that the author may be rather optimistic in stating that slabs will usually return to their original level after thawing of the subgrade.

Lean-mix bases are discussed at some length and it is interesting to note that hand spreading is advocated since no small spreaders are available as yet and the use of large machines is uneconomic. Another interesting point mentioned by the author is the fact that cracking in this material can be prevented by the use of light reinforcement. Many practical details are given in this section of the book and these are of much topical value in view of the increasing use of this type of construction.

Soil-cement roads are fully discussed and in this subject much practical advice is given but one point gives rise to fresh thought : the author is firm that the moisture content of the soil-cement mixture, as given by the B.S. (or Proctor) test in the laboratory should never be exceeded in the field, but a small addition, not exceeding 1 per cent, has been used quite commonly to compensate for the drying out during pulverisation and exposure to the atmosphere. In pointing out that soil-cement stabilisation should not be attempted during heavy rain, or when there is a threat of frost, the author might well have added that a persistent high wind is also unfavourable and an unpredictable, but very appreciable, amount of cement can be blown away during *in-situ* mixing.

The book is commendably free from misprints, except for the somewhat unfortunate " Cassegrande " which somehow crept in on page 127, but the illustrations, of which there are many, would have reproduced better on a paper of smoother texture. It is a very readable book, full of sound practical information and, as such, it should be carefully studied by every site engineer and contractor's agent where concrete or soil-cement is being used in road or runway construction.

Books of Reference

Electrical Trades Directory : The " Electrical Journal " Blue Book, 1960. Edited by Norman H. Codling, D.F.H. (Hons.), A.M.I.E.E. Benn Brothers, Ltd., 154, Fleet Street, London, E.C.4. Price 63s.—This comprehensive source of information about the electrical and allied trades, their products and the services that they offer, is now in its seventy-eighth year of publication. Information about electronic equipment, with its increasing industrial and commercial applications, has in this edition been arranged in a section of its own. There are references to 5500 electrical manufacturing and other companies and to 2600 of their main products ; 550 merchants, exporters, importers and agents ; 3500 electrical installation contractors ; 570 electrical wholesalers and 300 radio wholesalers ; and nearly 300 scientific and technical societies and trade associations.

English-Polish Dictionary of Mechanical Engineering. Edited by S. Czerni. Panstwowe Wydawnictwa Techniczne Warszawa, 10, ul. Mazowiecka 2/4, Warsaw. Price zl.98.—This dictionary contains, arranged in alphabetical order, about 38,000 technical terms compiled from British and American sources with Polish equivalents and definitions. The dictionary is supplemented by a list of current abbreviations used in Anglo-Saxon technical literature. Fields covered include mechanics and machine elements, materials, metallurgy, production techniques, control and automation, power, materials handling, transport, armaments, management, and economics.

Books Received

Radar. By T. J. Morgan. Frederick Muller, Ltd., 110, Fleet Street, London, E.C.4. Price 9s. 6d.

Roll Pass Design. The United Steel Companies, Ltd., P.O. Box 64, The Mount, Broomhill, Sheffield, 10.

Practical Welding Repairs. By C. G. Bainbridge. Temple Press, Ltd., Bowling Green Lane, London, E.C.1. Price 15s.

The Story of Engineering. By James Kip Finch. Doubleday and Co. Inc., Garden City, New York. Price 1.45 dollars.

Applied Mechanics for Engineers: Statics, Dynamics, Strength of Materials. By James C. Grassie. Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, London, W.1. Price 45s.

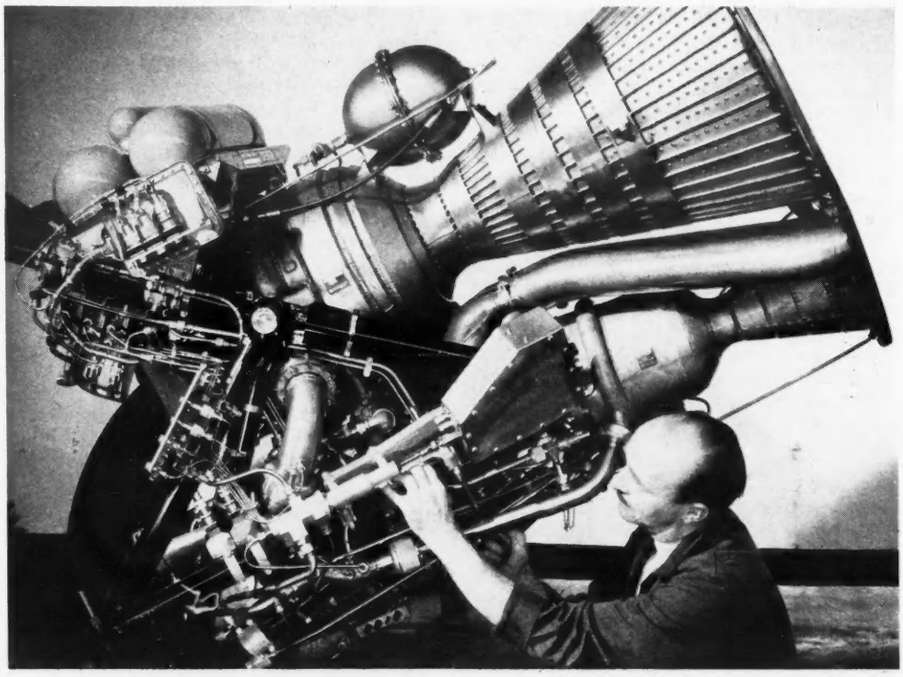
Reinforced Concrete Reservoirs and Tanks. Fourth Edition. By W. S. Gray. Revised by G. P. Manning. Concrete Publications, Ltd., 14, Dartmouth, Street, London, S.W.1. Price 12s.

Mechanical Properties of Intermetallic Compounds. Edited by J. H. Westbrook. John Wiley and Sons, Inc. New York. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 76s.

New Aero Engines

THE names of two new engines and further details of a third have been disclosed by British Siddeley Engines, Ltd.

The Bristol Siddeley " Stentor " B.S.St.1-1 is a hydrogen peroxide rocket in production at Coventry for the Avro " Blue Steel " air-launched cruise missile, development rounds of which have used the D.H. " Double Spectre," another h.t.p. engine. The " Stentor " is seen in our illustration to be a much larger engine, but to have, in common with the earlier unit, two combustion systems, although of different sizes. It may be inferred that the large one is used only to drive the missile up to its cruising altitude, and that the smaller one acts as a sustainer ; no claim is made that either chamber is throttlable, but in all probability the smaller is variable in thrust to allow cruising at a selected Mach number for, say, best range. H.t.p. and kerosene are fed to the chambers by a turbo-pump, the exhausts from which can be seen running back to the " transom " of the missile, and the peroxide tank for starting can be seen above the throat of the top chamber. The nozzles are cooled by passing oxidant forward through the walls ; the construction that allows this is not clear in the photograph, although the longitudinal spines appear to be welds. The injectors are purged before and after each run with nitrogen, stored in cylinders at the top front of the engine, and in order that the engine shall survive long periods of storage without suffering corrosion, provision is made for drying out the peroxide system with hot air after test firings (see page 137, July 22, 1960).

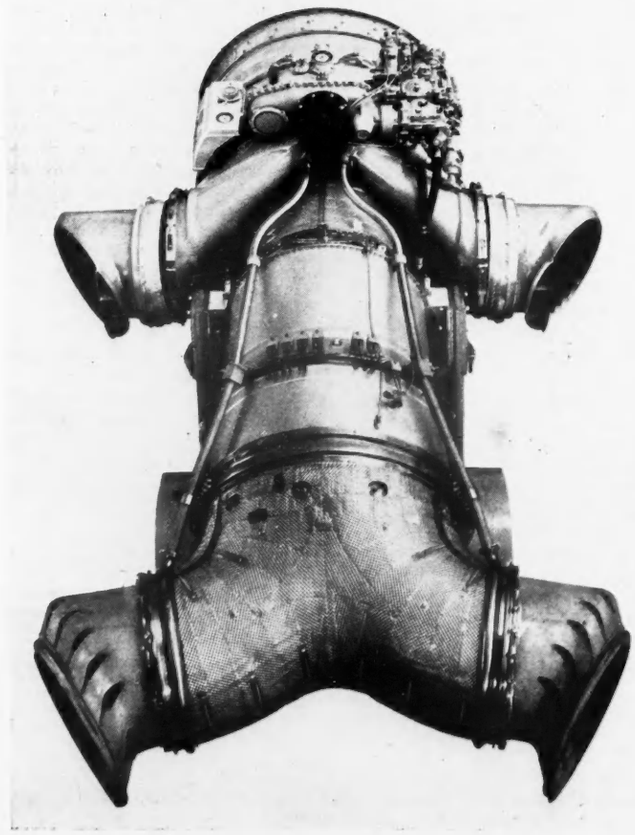


The " Stentor " engine ; being used in an air-launched cruise missile, it does not need pivoting nozzles. The control system appears to be electric

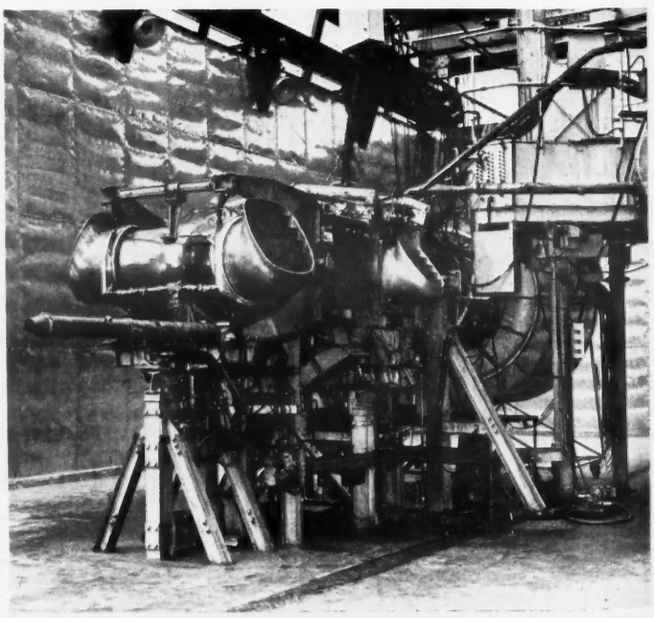
It is observed by the manufacturers that they have experience with both hydrogen peroxide, in the " Gamma " and " Stentor " missile engines, and liquid oxygen in the " Snarler " and " Screamer " aeroplane engines. This inversion of the usual selection of fuels, missiles needing high specific impulse to attain required performance and aircraft sacrificing performance for safety, is attributable largely to the Ministry of Supply decision after the " Screamer " was cleared for flight to abandon the development of liquid oxygen engines, those of " Blue Streak " being basically Rocketdyne designs.

The second new engine is the Bristol Siddeley BSRJ 824 ramjet. The only details available are : length, 99·6in ; diameter, 18in. This is the same diameter as the BRJ 801 seen at Farnborough in 1958, and the engine is possibly a development of this unit. It is intended for use at " high altitude and high supersonic speeds " ; a " full evaluation " has been performed in the high altitude test plant at Bristol, and service trials have demonstrated the ease of handling associated with kerosene-fuelled ramjets ; it is not fully established that the engine has run in free flight.

Some photographs are reproduced here of the Bristol Siddeley BS 53 ducted fan, showing the movable elements of the thrust vectoring system. This engine has been selected for the Hawker P.1127 V.T.O.L. close support fighter. One advantage of the use of movable nozzles on a single lift-thrust engine is that, provided the direction control system is reliable and rapid in response, the jets need only be directed on to the surface of the ground at the moment of take-off, and if some run is allowed the dust and debris will not be aspired into the engine. Such an engine also implies the ability to fly overloaded as an S.T.O.L., offering long ferrying ranges. One remarkable feature that has been disclosed is that high-pressure and low-pressure spools



(Left) A BS 53 lift/thrust ducted fan; notice the pipes ducting air to the bearings of the exhaust nozzles, and the hollow turning vanes at the hot end



A BS 53 on the test bed, with the nozzles set to augment the weight of the unit ; the drive rotating the exhaust nozzles can be seen below the turbine outlet bifurcation

contra-rotate, reducing the precession torques ; this characteristic presumably stems from the objection of the hovering auto-stabilisation system to pitch-yaw coupling, and must have complicated the design of the bearings severely. The h.p. line is a very simple assembly of seven compressor stages and one turbine stage like that of the "Orpheus," supported between two bearings ; since bearing supports cannot be passed between the h.p. and l.p. turbines, the h.p. turbine bearing is supported on the shaft driving the l.p. compressor and runs at the sum of the turbine speeds. Since the usefulness of a V.T.O.L. aircraft depends critically on the thrust-weight ratio of the engine, it can be understood that conservatism in the basic design would be out of place.

Our illustrations show some details of the engines ; notice that two different designs of nozzles for both the fan and turbine jets are shown. The small pipe below the exhaust on the test bed may deliver hot gas to a reaction control system for use at low air speeds. The fact that the nozzles turn vertically upward is presumably largely to enable testing to be carried out conveniently.

Building Research, 1959

THE D.S.I.R's annual report on building research for the year 1959 has just been published.* The year was clearly an active one, and there is much of interest in the report. For those interested in structures, further progress is noted in those lines of research which the Building Research Station has been pursuing for some years, notably in the study of shrinkage and creep in concrete nuclear reactor shields, multi-storey steel frames and composite action in buildings, shear in reinforced concrete, concrete shell roofing and the strength of brickwork, "no fines," and lightweight concrete, and vibration of structures. Apart from the design and performance of structures, the main topics of research, are, as customarily, grouped under the heading of "materials," "soil mechanics," "efficiency of buildings," and "building operations."

The report is demonstrative of the value of the broadest approach to some building problems, particularly economic ones. For instance, the relative costs of different kinds of housing, and urban development are commented upon, and it is pointed out that the economic implications of the housing programme are wider than is sometimes appreciated. Another general survey which has been initiated concerns hospital design and construction. Government expenditure on hospitals is to increase substantially—it may amount to £300 million over the next six or seven years—and there is much scope for rewarding research in this field. For example, the cost of engineering services in hospitals (heating and ventilation, operating theatre services, lighting, &c.) can amount to a third of the total building cost. Ways of providing these services more economically will be studied by the Station. Cost studies will also be carried out on recently constructed hospitals in an effort to identify other parts of the building process where economies might be achieved. It should be possible to pick out anomalies in building costs between different hospitals of similar capacity and to trace their causes. Engineering services are important not only in hospitals. In most large buildings engineering installations have become increasingly complex and expensive. Their integration with the building design and in the process of construction frequently cause dislocation and delay. The Station is investigating these problems.

The following representative examples of work at the Building Research Station have been abstracted from the annual report. The first is purely a civil engineering problem, and the second relates to the more general approach we have just mentioned.

The Bakerloo Line Tunnels and the "Shell" Building

In *Building Research*, 1958 (page 30), reference was made to an investigation that had been commenced to follow the influence of the construction work for the new Shell Headquarters building on the Bakerloo tube tunnels that lie beneath the site on the South Bank of the Thames.† A broad indication was given of the instruments installed to measure deformations and stress changes in the cast-iron linings of the tunnels. In collaboration with the London Transport Executive, observations have been taken with these instruments at intervals throughout the year, during which the large excavation for the building has been completed and the construction of the superstructure begun. Their performance throughout has been very satisfactory.

It has not yet been possible to analyse all the data so far obtained, but it may be of interest to indicate in broad terms some of the effects on the tunnels of the excavation of the 40ft of ground cover (to within about 4ft of the crown of the uppermost tunnel) over a distance of about 120 yards. The southbound tunnel lies immediately on top of the northbound across most of the site, and the excavation gave rise to greater displacement and deformations in the southbound or upper tunnel than in the lower one. The roof of the upper tunnel lifted about 1in beneath the excavation and settled nearly $\frac{1}{2}$in for some distance outside the excavation. The floor of the upper tunnel lifted less than the roof (only about $\frac{3}{4}$in), and the floor of the lower tunnel lifted even less (about $\frac{1}{2}$in). Thus, beneath the excavated area the vertical diameters of both tunnels increased, the extension of the upper tunnel diameter being about $\frac{1}{4}$in.

Where the ground expanded vertically with the relief of load beneath the excavation it contracted laterally, like an elastic solid. The horizontal diameters and the axial lengths of both tunnels decreased. The reduction in the horizontal diameter of the upper tunnel beneath the excavation was about $\frac{1}{8}$in. The axial compression in the same tunnel near the centre of the site was about 1/20in in a distance equivalent to a diameter (i.e. 12ft).

These displacements and deformations of the tunnels were accompanied by a general reduction in the compressive stresses in the cast-iron lining, and also by a bending of the lining segments. Under the centre of the excavation the average circumferential stress released from four rings of lining (two in the upper and two in the lower tunnel) was about 0·8 ton per square inch, a value which is in good agreement with the estimated pressure of the total overburden. But, on account of bending in the segments, compressive stresses of over 2 tons per square inch were released in some places at certain stages in the course of excavation.

Observation is being continued and measurements are being made to follow the effects of the erection of the superstructure of the building, and the long-term effects of any swelling of the clay.

Economics of Housing and Urban Development

The cost of constructing housing is only the first expense in which the community is involved. The housing must be provided with all the usual public utility services, with roads and sewers, and with all the public, commercial and industrial services which are necessary today for normal urban life. To obtain a true picture of the impact of a housing development on the resources of the community, it is necessary to consider not only the cost of construction but also the costs of maintaining and servicing the housing and the effect of the housing on the living and working costs of the people who occupy and service it. The location of the housing further affects costs, particularly the costs of travel and food for its occupants ; the size of the town and the location of the housing in relation to shopping, educational, and industrial centres, are important.

Dwellings in high blocks of flats cost about two-thirds more to construct than two-storey dwellings. While the resulting higher densities give some savings in the cost of land, normally neither these savings, nor the small savings in the cost of site development, go far to offset the higher costs of constructing the high blocks. On the other hand the cost of maintenance and management is also of the order of 50 per cent greater in high blocks than low ones. The savings in the cost of land are, of course, only of importance to the developer, since to the community the cost of land is a transfer payment.

The advantage of high-density redevelopment in the centre of cities is that it reduces the number of people who must be rehoused, either in distant suburbs or in other towns some distance from their former homes. Suburban development usually necessitates the provision of local shopping, schools, open spaces and other neighbourhood facilities, which together cost about £750,003 for each 10,000 persons. The cost of creating complete town facilities, as is often necessary with new towns, is about £90,000,000 for a new town of 80,000 persons. Of this sum about 60 per cent would be for housing, assuming that this was of the normal two-storey construction. In addition to the costs of construction, there are the costs of moving people and commercial, social and industrial equipment, and the resulting disturbance to industry. For a new town of 80,000 persons this might amount to about £5,000,000. As against these costs the new development will have a longer potential life than the old buildings, usually lower running costs, and will be cheaper to operate in. Thus the real costs of overspill development are substantially lower than they appear at first sight, whereas there is no extra improvement value which can be set against the extra costs of high as compared with low residential development. Moreover, the costs of living are likely to be somewhat lower in small towns than in conurbations and large towns.

It is clear that, in general, the scope for using high-block residential buildings as a means of reducing the cost of providing housing and its accompanying urban amenities is very limited. However, in this field the study of general cases is of only limited value, and it is necessary to examine the situation individually for each area. The techniques and cost data that have been derived by the Station's study should provide a basis on which planners can assess the balance of advantages and disadvantages for the particular situations with which they have to deal, and weigh them against the more imponderable factors of amenity and city life.

*H.M. Stationery Office. Price 7s.

†See also THE ENGINEER, August 30, 1957, page 298.

Grants for Space Research

IT has been announced by the Department of Scientific and Industrial Research that sixteen grants to Universities for space research projects —satellite instrumentation, upper atmosphere investigations, &c.—totalling £184,540, have been made on the recommendation of the British National Committee on Space Research, set up by the Royal Society under the chairmanship of Professor Sir Harrie Massey. Several other grants are under consideration. The grants, covering a variety of periods, are for salaries of staff, travel and subsistence, and development or purchase of special equipment.

These grants have been approved by the Steering Group for Space Research, set up by the Minister for Science under the chairmanship of Professor Sir Edward Bullard, and the financial responsibility for them is with the Department of Scientific and Industrial Research.

THE 1960 CYCLE AND MOTOR-CYCLE SHOW.—From November 12 to November 19, 1960, the British Cycle and Motor-Cycle Industries Association, Ltd., in celebration of its Golden Jubilee, is organising the Thirty-third International Cycle and Motor-Cycle Show. The exhibition will occupy the ground and first floors at Earls Court. Applications for space should be made to the show manager, the British Cycle and Motor-Cycle Industries Association, Ltd., Eaton Road, Coventry.

"Pumpability" of Waxy Crude Oils

By V. S. SWAMINATHAN*

The characteristics of Assam crude oil with its high wax content (Digboi oil wax content is 16·5 per cent and pour point 90 deg. Fah., and Nahorkatiya oil wax content is 11·5 per cent and pour point 90 deg. Fah.), and the climatic conditions of the regions which will be traversed by a 720-mile pipeline have presented an unusual pumping problem. For over three years now there have been experiments in the field and studies in laboratories in Assam and the United Kingdom to record its behaviour in pumps, pipeline, storage tanks and on the move. Exhaustive tests have demonstrated that the crude is pumpable in a pipeline at any season of the year. In this article the investigations conducted in Assam are reviewed.

Once it was appreciated that Nahorkatiya in North-Eastern India was developing into a major oilfield and that a refinery or refineries would have to be set up elsewhere to process the crude oil, the Assam Oil Company (A.O.C.), Ltd., started investigations on the pumpability of waxy crude from this oilfield in 1956. These were undertaken in several phases, the last but one being model field experiments which can be directly applied for calculating pressure losses per mile through a pipe of any size transporting crude petroleum at a given rate. Since there was little available information on the subject the problem was studied from all possible angles. The experience of the A.O.C. up to the end of 1955 is briefly stated. Crude oil from the Digboi oilfield, which has about the same pour point as the Nahorkatiya (NHK for short) crude, could not be pumped through a surface line from field to refinery (less than 10 miles) on some winter days even when it was heated. A surface line laid from NHK to Digboi (a distance of 23 miles) could transport crude on winter days only when the afternoon sun played on the line.

To start with, the answer to the question why should waxy crude be more difficult to pump, had to be found. This is not as simple as it appears. Through diverse indirect ways the amount of wax separated at a temperature at or below the pour point was measured. At 85 deg. Fah., for instance, the amount of wax separated from NHK crude is less than 1 per cent. This should not render the crude solid in the pour point apparatus unless there are extremely asymmetric crystals which interlock with one another to form a rigid three dimensional structure. Two interdependent causes for the rigidity of the crude were found, namely, (1) gradual separation of wax from the crude occurring with the lowering of the temperature, and (2) formation of a three dimensional network by the asymmetric wax crystals. Investigations were, therefore, initially directed to reduce the separation of wax on cooling and then to break the structure while it was forming.

Meantime, information was collected regarding temperatures likely to be met with in the transportation of NHK crude. Conclusions reached are summed up thus : (*a*) Surface temperatures under shade along the proposed route vary between 45 deg. Fah. (minimum) and 110 deg. Fah. (maximum) over the year, (*b*) underground temperature at 4ft ranges between 65 deg. Fah. and 85 deg. Fah. during the year ; there is no variation between morning and evening. (*c*) Higher temperatures can be maintained by heating the entire length of the pipeline. This, however, would be a very costly proposition. (*d*) If heating is effected at boosting stations only, the pumpability would be adversely affected under normal conditions.

Work on how to minimise wax separation, or how to increase wax solubility in the crude, was carried out in several steps. The findings are recapitulated below :

(*a*) Separation of wax can be minimised by the addition of solvent oil, kerosene or another low wax crude. The minimum effective dosage required would be approximately 25 per cent.

* Assam Oil Company Ltd., New Delhi, 1.

(*b*) The lighter the solvent added the higher the solubility of wax in it. In this respect butanes and propane would prove the best solvents.

(*c*) The most economic way to increase the butane and propane contents of the crude is by multistage separation. The latter step also increases the volume of crude obtained, and the cost of extra separators can be recovered in a year.

(*d*) Use of pour point depressants was not considered as this would be uneconomic. When work on multistage separation was under way, it was realised that the conventional type storage tanks would not be suitable for storing the crude following the loss of light ends from the open vents. Some model experiments were therefore carried out on storage tanks which indicated that floating roof tanks would meet the needs of the situation.

It was noticed that by multistage separation the set point of NHK crude could be reduced from 85 deg. Fah. to about 78 deg. Fah. However, this was still some 13 deg. Fah. above the minimum temperature at 4ft underground, but it was considered that the set point could be reduced 13 deg. or more by suitably breaking the structure. The salient features of the observations of A.O.C. workers in India on this point were :

(*a*) The structure can be broken by working the crude while cooling and then not letting it warm up once more.

(*b*) The rate of cooling and that of working have some influence on the ultimate structure.

(*c*) The structure could be effectively broken when the crude is cooled at a workable rate through a D.P. chiller to 65 deg. Fah., with the scraper running at moderate speeds, followed by one pass through a pump. Dimensional model experiments with multistage flashed crude, which have been cooled and worked, showed that the expected pressure loss in a 16in line transporting 2,750,000 tons of crude per year would be 15 lb per square inch per mile.

Model experiments were conducted with the multistage flashed crude at various underground temperatures using buried lines. The dimensions of the lines employed up to 1958 were : 500ft of 1in line, 4500ft of 4in line and 7 miles of 8in line. Inasmuch as pressure loss in a line is proportional to the fourth power of radius in the range of the viscous flow and to the fifth power of radius in turbulent flow it is easily seen that the dimensions of the above pipelines, especially the 8in line, are proportional to about 100 miles or more of 16in pipe. Results thus obtained showed that for a 16in pipe buried 4ft underground transporting 2,750,000 tons of NHK crude the pressure loss per mile under minimum temperature conditions would be 15 lb per square inch per mile.

All the above experiments were carried out with crude cooled by being kept in the underground line and then the structure broken by rapid pumping, whereas for the actual transport of NHK crude one will have to employ artificial cooling. It was reckoned that artificial cooling would be better than the natural one which (latter) is a very slow process. The latest series of pumping experiments done inside the A.O.C. Digboi refinery were with artificially chilled crude, and they proved very satisfactory. The responsibility of the work was shifted to the United Kingdom in July, 1958. Any new observations made in Britain will no doubt be checked at the Assam end before they can be finally accepted and put into practice.

The Oil India Private, Ltd., with an initial authorised capital of Rs.50 crores (two-thirds held by the Burmah Oil Company (B.O.C.), Ltd., which owns the Assam Oil Company, and one-third by the Government of India), has arranged for the construction in two stages, and operation of a pipeline for the transport of crude oil to be produced by it from the NHK and Moran oilfields to the two public sector refineries, one at Nunmati near Gauhati in Assam and the other at Barauni in Bihar, a total distance of about 720 miles from Nahorkatiya. For building the pipeline the Burmah Oil Company (Pipe Lines), Ltd., a wholly owned subsidiary of the B.O.C., Ltd., was appointed by an agreement between the Government of India and the B.O.C., Ltd. To finance the pipeline expenditure the B.O.C., Ltd. has offered to make a loan to the company in the United Kingdom up to £20,000,000 and the U.K. Government has authorised a loan of £3,000,000 to the Government of India to meet the foreign exchange requirements of the cost of the pipeline. The rupee expenditure for the pipeline is expected to be about Rs.25 crores.

The Nunmati refinery with a capacity of 750,000 tons per annum is expected to be on stream by December, 1961 ; the first unit of Barauni refinery with a capacity of 1,000,000 tons is scheduled to be started by July-September, 1962, and the second unit of the same plant, also of 1,000,000 tons per annum intake, is reckoned to be commissioned by April-June the following year.

By April-June, 1963, Oil India would therefore be supplying these two processing units 2,750,000 tons of crude oil a year. The pipeline to Nunmati has to be completed by December, 1961, and up to Barauni by July-September, 1962. The diameter of the pipeline up to Nunmati will be 16in and from there to Barauni it will be 14in.

Technical Reports

Detection of Gamma Radiation by Induced Conductivity. By C. G. Clayton, U.K.A.E.A. Research Group, Harwell. H.M. Stationery Office. Price 4s. —The measurement of induced photoconductivity in insulators and semiconductors can be used for the detection of beta and gamma radiation and the potentialities of such methods of detection are being explored at Harwell. Two kinds of photoconductors are in use as radiation detectors—namely, the pure insulators (such as polyethylene and polystyrene) and the intrinsic and extrinsic semiconductors such as cadmium sulphide, cadmium selenide and gallium arsenide. This report examines some of the characteristics of photoconductors that are significant in radiation detection.

The Behaviour of Metals Under High Hydrostatic Pressure. III.—*Extrusion Under Pressure.* By H. Ll. Pugh and D. Green. M.E.R.L. Plasticity Report No. 147, National Engineering Laboratory, East Kilbride, Glasgow.—Since a super-imposed fluid pressure makes possible deformation of a material to a much greater degree than is normally possible at atmospheric pressure, it was thought that an improvement could be expected in the " pressurised " extrusion of difficult materials. This report describes an apparatus for carrying out extrusion under a super-imposed fluid pressure and the results obtained for bismuth and magnesium. It is concluded that extrusions formed in the presence of a pressurised fluid will be perfectly satisfactory in cases where, because of the type of material, and/or extrusion ratio, unsatisfactory products result at atmospheric pressure ; moreover, the product extruded in the fluid is likely to have enhanced properties. If an increase in the hydrostatic component of the stress system is effected by increasing the extrusion ratio, the temperature of the product is increased, and this may have deleterious or advantageous effects.

Multiple Purpose River Basin Development. Part 2c : *Water Resources Development in British Borneo, Federation of Malaya, Indonesia and Thailand.* United Nations, Bangkok. H.M. Stationery Office. Price 14s.—This report is No. 14 in the United Nations flood control series, in which an extensive exploration of the problems surrounding the control and exploitation of the rivers of the Far East has been made. In this report, an appraisal is given of the hydrological and climatic characteristics of each of the countries listed in the title. In each case the major factors, whether technical or economic, influencing development of the river catchments is discussed. An appraisal of the present state of the art in each country is also given. The report emphasises the lack of basic data, and hence absence of development, within the area generally, but some major engineering achievements are recorded in Thailand, where some 10 per cent of the vast potential water resources has been developed for irrigation, and a programme of further development for irrigation and also for power generation is in progress. The report stresses that in the other three countries, whose water resources are virtually untouched, development for water power especially would have a markedly if not critically beneficial effect on their national economies.

SHORTER REPORTS

Nuclear Power Station Sites in Anglesey

As a result of investigations by the Central Electricity Generating Board for possible nuclear power station sites in Anglesey, suitable sites have been found at Wylfa, Carmel and Trefadog in the north-western part of the Island. The Wylfa site is on the north coast, about 1½ miles west of Cemaes Bay ; the Carmel site is further west, almost at the north-western corner of the Island and the Trefadog site is on the west coast about 4 miles south of the Carmel site. The Generating Board has considered these sites together with that at Edern on the north coast of the Lleyn Peninsula and it has come to the conclusion that when a second nuclear power station is required in North Wales it would propose to seek permission to the development of the Wylfa site.

It will be recalled that in August, 1957, when the Central Electricity Authority announced its intention to apply for consent to develop a nuclear power station at Trawsfynydd, Merionethshire, and to build a short transmission line to Ffestiniog, it was stated that a suitable site for a nuclear power station existed at Edern in Caernarvonshire. It was also stated that the "timing of proposals for Edern will depend upon system requirements and the scale of the nuclear programme as a whole." In February, 1959, the Central Electricity Generating Board announced the extension of the investigations of possible nuclear sites to Anglesey, stating that a second new station in North Wales would entail new transmission lines and that any suitable site would need to be considered along with that at Edern.

The investigations have shown that one of the Anglesey sites—Wylfa—is marginally superior to Edern on economic grounds and the Board's opinion is that it is by a similar margin also more acceptable from a planning and amenity point of view. It is for these reasons that the Generating Board now proposes that a station at Wylfa should precede one at Edern. One result of the recent revision of the British nuclear power programme is that the investigation of suitable sites is well in advance of immediate requirements. At present the C.E.G.B. cannot forecast accurately when any of the Anglesey sites might be required for development. However, the station at Wylfa will not be required in the period up to and including 1966 which means that construction could not begin before 1963 at the earliest. Edern remains a technically suitable site but it is not possible to forecast when proposals for its use might be made.

Institute of Metals: Autumn Meeting

THE fifty-second annual autumn meeting of the Institute of Metals will be centred on Bath, from September 5 to 9, 1960. This will be the first time that the Institute has met in the West of England. The programme includes as usual a careful blending of technical sessions, works visits, places of interest to the ladies, and social functions.

Technical sessions have been arranged on three of the days for the presentation and discussion of papers which have recently been published in the *Journal*, or will be distributed to members registering for the meeting. These fourteen papers will be considered in one or other of the simultaneous sessions arranged for Monday, Tuesday and Thursday. On Friday Sir Alfred Pugsley, O.B.E., D.Sc., F.R.S., Professor of Civil Engineering, University of Bristol, is to give the Autumn Lecture on "Metals and the World of Engineering Structures."

Visits have been planned for the afternoons of Tuesday and Thursday ; Wednesday has been left free for all-day visits. In all, members and their ladies are offered a list to choose from of eighteen works and nine places of interest.

Three social events have been organised ; a cocktail party on the evening of the first day, a civic reception and dance by invitation of the mayor of Bath, and a dinner, divided between two evenings. This latter is by invitation of the reception committee, which, under the chairmanship of Mr. D. M. G. Sneddon, general manager, Imperial Smelting Corporation, Ltd., Avonmouth, has been responsible for the meeting programme.

Diamond Jubilee of the Central Line

AN exhibition illustrating the sixty years' history of the Central Line, London Transport, was opened in the booking hall of Charing Cross Underground station, London, on August 9 and will continue until September 7. Originally known as the Central London Railway, the first section of the line was opened to the public over the 5¾ miles between Shepherds Bush and the Bank on July 30, 1900. It was the third tube railway in London, being preceded by the City and South London on December 18, 1890, and the Waterloo and City on August 8, 1898. Trains were worked at first by bogie locomotives with four 200 h.p. gearless motors, the armatures being mounted directly on the axles, but vibration caused by the high proportion of unsprung weight disturbed property owners along the line and led to the setting up of a Board of Trade Committee to investigate the problem. The committee having established that serious vibration existed, the railway fitted three locomotives with 150 h.p. geared motors and also made up two six-car trains with two cars in each train equipped as motor coaches by fitting each with two 100 h.p. geared motors. Tests with the geared locomotive showed that vibration was much reduced, but no vibration was noticed at any point on the surface when the motor coach trains ran below. As a result the railway decided to replace the locomotives by sixty-four motor coaches and to operate seven-car trains. A new motor giving 125 h.p. was designed for the new stock, giving 500 h.p. per train, and by June, 1903, the service was being fully worked by these seven-car sets. The motors of both power cars in a train were controlled through contactor switchgear in a compartment behind the driving cab and the trains represented the first application in this country of multiple-unit control principles. Since the motors were of large diameter, the frames had to be raised to clear them, and the space above would in any case not have been sufficient for passenger seating. Notching was at first controlled by hand, but automatic acceleration was incorporated later. Although motor coach trains had been operated from the first on the Waterloo and City Railway, their motors were under direct control from the controller in the leading cab, to which those at the remote end were connected by power bus lines.

The Central London locomotives had direct series-parallel controllers consisting of 18in dia. wooden drums carrying copper contact segments. To assist the driver in manipulating this rather bulky drum switch, he was provided with a control handle 21in in length. After their withdrawal, two of the locomotives were adapted and used by J. S. Raworth to demonstrate his regenerative braking system on the Metropolitan Railway before the first world war. The last of the series of twenty-eight remained in service for shunting duties until 1948.

Locomotives, rolling stock and many other past and present features of the Central Line feature in prints, photographs, posters and models now on display at the Charing Cross exhibition. The line to-day is 51¼ route-miles in length and serves fifty-two stations from West Ruislip in the west to Ongar and Hainault in the east. Its most recent extension has been the electrification of the Epping-Ongar section on November 18, 1957. Since the 1939-45 war trains have been formed of rolling stock displaced from the Bakerloo and Northern Lines when these received new tube stock of the 1938 pattern with under-floor control equipment. Thus the Central Line continued to be operated by trains with equipment compartments behind the driving cabs, but the space occupied was less of a drawback here than on other parts of the London Transport system because the ability to accommodate eight-car trains at the Central Line stations compensated for the encroachment on seating space. For some months two seven-car trains of the new "silver" tube stock with under-floor equipment have been running on the line, mainly for crew training, and since the jubilee anniversary week itself, beginning on July 25, the first eight-car trains of this new 1959 tube stock have been introduced.

At Oxford Circus station there is already interchange with the Bakerloo Line of London Transport, and if final approval is given to the building of the proposed Victoria Line, this station will become a point of interchange between the three routes. A model at the Charing Cross exhibition showing how it is proposed to deal with Oxford Circus station when it can be rebuilt includes the siting of the northbound and southbound Victoria line platforms on each side of the corresponding Bakerloo tracks, with the Central Line platforms at right angles on a lower level.

Transatlantic Cable Between the United Kingdom and the U.S.A.

A NEW transatlantic telephone cable, to come into service in 1963, is envisaged in a recent agreement between the British Post Office and the American Telephone and Telegraph Company, subject to approval by a resolution of the House of Commons. The cable will be designed to carry 128 telephone circuits between the United Kingdom and the U.S.A. and its commissioning will be opportune, for the traffic is growing at the rate of about 500 calls a month and is now three and a half times greater than it was before the first transatlantic cable was opened in 1956. Initially, some of the circuits in the new cable will be used for telephone calls to Europe, thus giving some relief to the cable that was opened in 1959 between France and the U.S.A.

Although the landing points have not yet been settled it has been decided that the cable will be laid directly between the United Kingdom and the the U.S.A., unlike the two existing transatlantic telephone cables both of which are routed via Newfoundland.

The new cable (designated TAT3) will have a total length of about 3400 nautical miles and will be of lightweight design, insulated with polythene and having no external armouring—a form of construction that will be used for the first time in the cable which is to be laid next year between the United Kingdom and Canada. A single cable with an overall diameter of 1¼in in the deep sea part of the route will carry speech in both directions. Rigid repeaters of a new design, developed by the Bell Telephone Laboratories, U.S.A., will be installed at intervals of about 20 miles along the cable to amplify the transmitted signals.

The cable will be used for transmitting telephony, telegraphy or radio programme material. It will not have sufficient bandwidth for television transmission. Responsibility for making and laying the cable (at an estimated cost of £12,000,000) will be shared by the British Post Office and the American Telephone and Telegraph Company, as joint owners of the installation.

SHORTER REPORTS *(Continued)*

A Hundred Years of Railway Carriages and Wagons

A CENTURY ago a small group of local business men met in Gloucester to discuss the formation of a company to build railway wagons. Two outsiders only—both railwaymen—were brought in, and the new concern was soon under way. At first sight Gloucester might not appear the ideal place to make railway wagons, and the year 1860 was not the most propitious of times to start a large new commercial venture, for the great financial panic following the end of the Crimean war had barely subsided. But the Gloucester men were right. They knew that the area was well placed for raw materials and labour, and that it was near enough to South Wales, Staffordshire and other mineral districts to break into the growing market for railway wagons. They were so confident, in fact, that they offered shareholders the prospect of dividends of not less than 8 per cent and perhaps 10 per cent. Their confidence was justified by events. Only eighteen months later the firm, known at first as the Gloucester Wagon Company, was paying 4s. per share for the half year on paid-up capital, and for a number of years the story of the firm was one of outstanding success.

Only ten years after its foundation the Company had a capital of half a million pounds, ranked as one of the leading firms in its field, and was doing a substantial export trade. It had thus reached, in a short time, the position which, as the Gloucester Railway Carriage and Wagon Company, Ltd., it holds to-day.

Railway wagons, both for sale and for hire, were the only products for some time, but in 1887 the change to the present style recognised an important addition to the output of the Gloucester works which had already been in being for some years. The first all-iron wagon was built in 1861, and from its earliest days the company has pioneered many different types of railway vehicle, some of them distinctly unusual. Among the latter was a gantry car for the Brighton and Rottingdean Seashore Company, which ran on two sets of tracks on the foreshore, and had the passenger car carried on a platform supported by iron legs above high tide level.

Some of the more unusual vehicles are illustrated, together with carriages and wagons of various standard types, in the well-produced centenary volume *A History of the Gloucester Railway Carriage & Wagon Company Limited*, issued by the firm.

World Oil Industry

THE statistical review of the world oil industry for 1959, published by the British Petroleum Company, Ltd., notes that the reserves showed about the same percentage increase as production. "Published Proved" reserves stood at 39,870 million tons compared with 37,455 million tons at the end of 1958, while the corresponding production totals were respectively 1000 million tons and 927 million tons, representing an increase of 8 per cent. The main producing area accounted for about two-thirds of the net increase in reserves and significant gains were made in North Africa and Argentina. Demand for oil continued the trend of the previous five years, the average rate of increase being about 7 per cent and the consumption total for 1959 being 985 million tons, compared with 925 million tons for the previous year. Oil refining capacity increased from 1011 million in 1958 to 1064 million tons in 1959, an increase of 5½ per cent compared with the average of 8 per cent for the last five years. The world tanker fleet increased by 5,200,000 tons to 60,900,000 tons despite the scrapping of 2,000,000 tons, but new tonnage under construction declined by 6,000,000 tons to 19,500,000. World energy demand, it is noted in the review, continued to grow at about 3 per cent per annum. In the historical section of the review brief statistical details of production and reserves, consumption and trade, are given.

Cooling Air for Food Packet Sealing

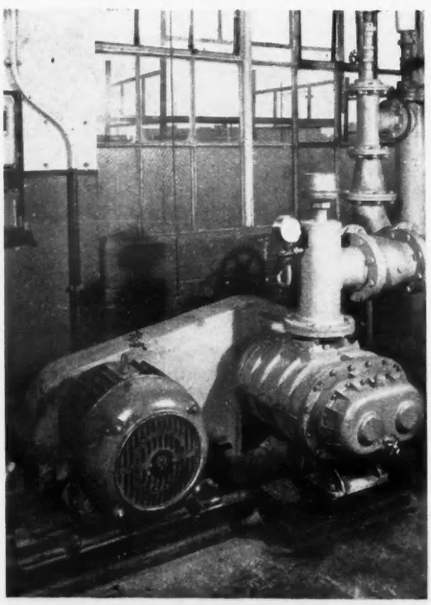
THE use of a sealed inner lining of wax paper in food packets, originally patented in the U.S.A. by the Kellogg Company, is well known. To seal the packet it is necessary to melt the wax at the open end of the liner by means of heated clamps and to compress the two sides of the liner between moving clamp chains ; these are spring loaded to give the pressure necessary to ensure an air-tight seal. The chains must be cooled to solidify the wax, and it is also necessary to keep the temperature below a certain critical figure to prevent the molten wax from adhering to the chain.

Cooled compressed air, blown through jets behind the chains is usually employed for cooling purposes. Approximately 10 cubic feet per minute at a temperature of about 50 deg. Fah. is required for each packing machine. This was provided in earlier types of plant by a standard reciprocating compressor at 40 lb per square inch. The delivered air then passed through an aftercooler into a decompressor adjacent to the packing machine. This was a reciprocating machine which allowed the air to expand adiabatically, giving a much reduced temperature—down to 20 deg. Fah. The supply of air from this machine was rather limited, and it became common in the U.S.A. to replace it with refrigerating plant to cool the air from the compressor aftercoolers.

It was realised that this method—using a high pressure and then expanding—was very costly, and in 1955 the Kellogg Company of Great Britain, Ltd., adopted a different method. They installed a 7in by 17in Holmes-Connersville positive air blower, built by W. C. Holmes and Company, Ltd., Turnbridge, Huddersfield, and working at only 1 lb per sq. in. This delivered air to an oversized aftercooler, where the outlet temperature was reduced to between 55 deg. and 60 deg. Fah. The abundant quantity of air compensated amply for the slightly higher temperature, and the resultant cooling was very effective. A duplicate system was installed in 1959 to supply air to the second packing department.

The original unit is still running twenty-four hours a day, six days a week, and has required no maintenance whatever since it was set to work. The incoming air supply is filtered, and the cooling effect is excellent, even in hot weather, when the plant is operating at peak capacity. Both installations are very compact, have been fitted into otherwise unusable spaces, and have released high-pressure air capacity for other purposes. Considerable interest has been aroused in the U.S.A., where, as far as is known, this type of installation has not so far been used.

[Reply Card No. E2823]



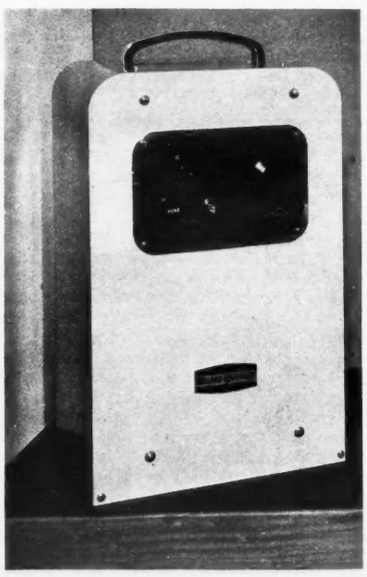
Compressor supplying air for sealing food packets

Ultrasonic Cleaner of 6 Litres Capacity

A NEW 500W ultrasonic cleaning unit having a capacity of over 6 litres has been developed by Mullard Equipment, Ltd. The unit is a bench-mounting model, suitable for various applications in industry, hospitals and laboratories: for example, cleaning hypodermic needles, surgical instruments or transistor components; degreasing hydraulic assemblies and diesel fuel injectors, or removing radioactive contamination from tools and instrument mechanisms, or polishing compounds from jewellery.

In the development of this design a special study was made to determine the optimum energy level per unit area of the transducer surface and the most efficient means of applying the ultrasonic energy to the cleaning fluid. As a result of this study it was decided to distribute the total available energy between twelve 40 kc/s transducers, measuring in all 6in by 8in, which completely cover the base of the cleaning tank. Dead spots are thus eliminated and effective and uniform cavitation is produced throughout the cleaning fluid.

The cleaning tank (not illustrated) is made of stainless steel and is 10in by 8in by 6in internally.



500W generator (14in by 12in by 10in) for ultrasonic cleaner. The cleaning tank, not shown here, has a capacity of 6 litres and is suitable for bench mounting

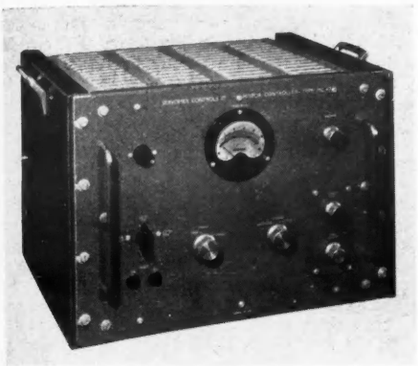
It is suitable for any of the normal cleaning agents, such as chlorinated and organic solvents, water solvents and mild acids. The corners of the tank and the transducer surfaces are rounded to prevent dirt being trapped. The tank is designed for bench mounting; its overall dimensions are about 14in by 12in by 10in.

Ultrasonic power is supplied by a separate bench-standing generator (illustrated), which delivers a peak output of 500W at 40 kc/s and operates from normal mains supplies. Only two controls are necessary, the on-off switch and the tuning control. The generator measures approximately 14in by 12in by 10in.

The equipment is distributed in the United Kingdom solely by Kerrys (Ultrasonics), Ltd., Harold Hill, Romford, Essex. Export inquiries should be addressed to Mullard Equipment, Ltd., Torrington Place, London, W.C.1.

Improved Motor Speed Controller

A SYSTEM for the precise control of an electric motor with a maximum output of ½ h.p. has been developed by Servomex Controls, Ltd., Crowborough, Sussex, and the relevant equipment is illustrated here. Briefly, the MC47 speed controller consists of a motor with a maximum speed of 7,500 r.p.m., forward or reverse ; the speed, as indicated by a multi-range meter on the front of the controller, is smoothly variable down to zero, and is stated to be stable to within ±2 r.p.m. Another advantage claimed for the system is that



Speed controller for ½ h.p. motor, 0 to 7500 r.p.m. with stability of ±2 r.p.m.

the method of dynamic braking that is incorporated ensures that there is the same resistance to accelerating and decelerating torques.

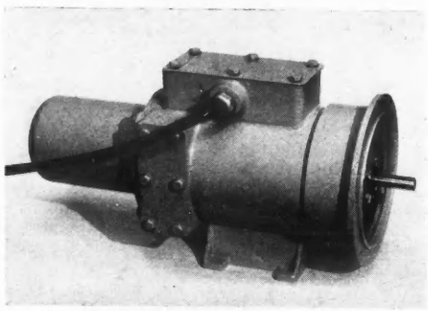
Control is based on the " Velodyne " principle: the shaft of the specially designed motor carries a generator with a linear characteristic to give a d.c. terminal voltage that is proportional to speed. This d.c. voltage is compared with a reference voltage in the controller and any difference is amplified in a servo-amplifier and applied to the motor field coils in such a sense as to correct the speed.

A special form of constant-current rectifier supplies the motor armature with direct current of practically constant value. The servo-amplifier controls the current in the field coils and the torque developed is, therefore, proportional to the field current, the armature current being constant, as stated. Inherently, therefore, the MC47 motor is a constant-torque (i.e. constant acceleration) system, which operates as a constant-speed device by virtue of the external servo-loop, through the tachometer generator and amplifier.

Compared with earlier versions of the " Velodyne " control, such as the Servomex MC43, the MC47 motor embodies a number of improvements. First, the power available is increased about fourfold, to give an output of ½ h.p. continuously at full speed. Secondly, the combined effect of a stiffer shaft and closer attention to the bearings and balancing of the rotor has been to give smoother operation over the whole speed range. Thirdly, to reduce speed variations with fluctuating torque, a flywheel is fitted. With it, the acceleration is 1000 r.p.m. per second and the speed " droop " on the application of full load is about 10 r.p.m. Better acceleration (7000 r.p.m. per second) can be achieved by removing the flywheel, when the damping can be restored by reducing the amplifier gain, but at the expense of an increased speed " droop " of 30 r.p.m. with full load applied. With or without the flywheel the damping is stated to be stable at all loads.

The instrument panel has coarse and smooth controls for a speed range of 0 ±7500 r.p.m. with a stability of ±2 r.p.m. hour-to-hour, after warming up, at constant load torque but with mains variations up to ±7 per cent from the nominal voltage and frequency.

The indicating meter has a scale length of 3½in and the four full-scale ranges are 10,000, 3000, 1000 and 300 r.p.m. the guaranteed



½ h.p. motor, fitted with tachogenerator, for use with MC47 speed controller shown on left

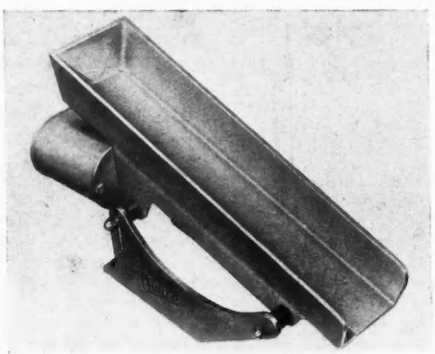
accuracy of reading and resetting being specified as better than 1·5 per cent.

The torque available is stated to be not less than 70 oz in (5000 g cm) over the whole speed range. With the flywheel fitted the moment of inertia is about 260 oz in² (48,000 g cm²). Without the flywheel the moment of inertia is about 37 oz in² (6800 g in²). The control panel is 19in wide by 14in high by 15in. (48·25cm by 35·6cm by 38cm) ; the motor, which is suitable for foot or flange mounting, has an overall length of 16½in (42cm). The motor is wound for a single-phase, 200V/250V, 50 c/s supply, but the armature supply tapping can be adjusted to suit a 60 c/s supply.

[Reply Card No. E2831]

Vibrating Feeder

THE magnetic vibratory feeder shown in the illustration is made by Magco, Ltd., Sake Works, Porchester, Hants, and has a maximum output of 10 tons an hour over its 8in wide tray. This equipment consists of a cast aluminium tray to



Magnetic vibratory feeder with a maximum capacity of 10 tons an hour

which the magnetic vibrator is directly attached. It can be mounted on two cast aluminium stands as illustrated or slung directly through tie rods from an overhead support.

The stands or tie rods are fixed to the tray structure through anti-vibration mountings to prevent transmission of vibration to other equipment. A slotted mounting at one end of the stands enables a tray to be adjusted at angles up to 10 deg. to suit particular requirements. The control fitted on the vibrator gives a stepless range of feeding rates from zero up to the 10 tons per hour maximum and we are informed that with fine silicon sands feeds as low as 1 lb per hour have been achieved.

[Reply Card No. E2832]

Portable Belt Conveyor

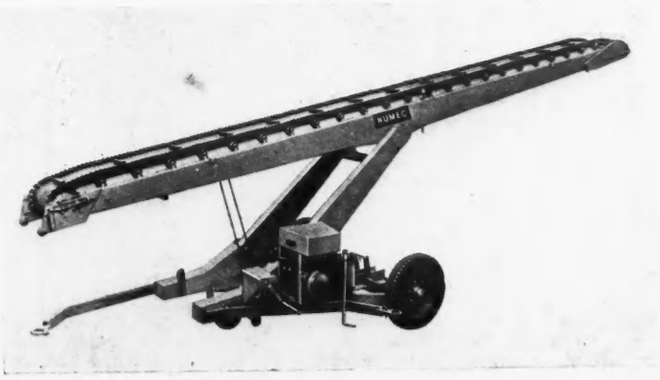
A PORTABLE belt conveyor, with a designed maximum capacity of 110 tons an hour and a belt speed up to 220ft per minute, now being made by Numec, Ltd., New Whittington, Chesterfield, is illustrated below. Its belt, made by the Dunlop Rubber Company, Ltd., is 16in wide and has 2in high corrugated sides which, with 8in by 1¾in high cross bars at 20in pitch, is stated to increase the bulk carrying capacity by some 50 per cent when compared with conventional belting of equal width. The boom has an overall length of just under 25ft with drum centres at 23ft 10in and is fitted with idler rollers set at 9¾in centres.

Boom angle is adjusted by a hand-operated winch and when one end is resting on the ground the working angle can be up to 45 deg. When inclined at this maximum angle the discharge height of the conveyor is 18ft 3in. The boom is supported from the base frame on elevating arms which are operated by hydraulic cylinders to adjust the height. Pressure fluid for operating these elevating cylinders is supplied from a hand-operated pump at the side of the engine. With this means of arm adjustment the horizontal height of the boom can be varied from 2ft 8in to 8ft 7in above ground level. In normal practice one end of the boom rests on the ground or the loading point, but it has been found that with both ends unsupported the balance is such that the machine can be used for light conveying duties.

The drive from a 320 c.c. petrol engine on the base frame is totally enclosed in the elevating arms and transmitted to the driving drum at the head of the boom. Two belt speeds of 125ft and 220ft per minute are available and a reversing gear enables the belt to be driven in either direction. This machine weighs 31 cwt and is mounted on two pneumatic-tyred wheels for towing purposes, whilst a castor wheel on one rearward extension of the base frame facilitates manoeuvring on site. Towing arms pivotally mounted on the frame are folded back against the side of the machine whilst it is in service. One of these towing arms can be seen in its operative position in the illustration below; the other one is swung back into its stowed position.

Brackets welded on the sides of the boom at top and bottom are used for the attachment of hoppers when handling loose materials on the conveyor. Extension pieces available for these hoppers enable their capacity to be varied in accordance with the class of material and working conditions.

[Reply Card No. E2833]



Portable belt conveyor with a maximum capacity of 110 tons an hour. This machine has hydraulically adjusted elevating arms and is driven by a 320 cc. petrol engine

SHORTER REPORTS *(Continued)*

Mobile Staging

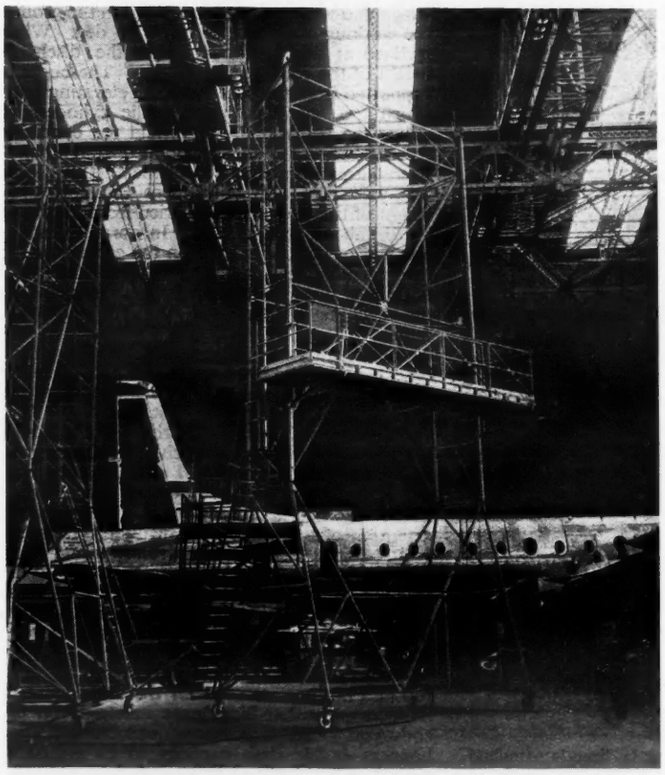
WE illustrate a mobile adjustable staging developed and built by Bristol Aircraft, Ltd. for use in servicing tail units on " Britannia " aircraft. This staging has a 4ft by 18ft platform which is raised and lowered over a height of 15ft to 35ft 6in and is designed for a safe load of 10 cwt or four men with 450 lb of equipment. The main framework of tubular steel construction is mounted on a rectangular base of rolled steel channel sections and vertical guide rails built into the main frame form tracks for the platform. Safety interlocks are fitted at each end of the platform structure and the main lifting cables.

A modified Atlas Copco pneumatic hoist attached to the main base frame is used for elevating and lowering the platform, the main lifting cables of which pass over a single sheave pulley at the top of each vertical guide rail. By means of two additional pulleys these main cables are brought together and attached to the safety hook of a single sheave block beneath which is the air hoist. One end of the winching cable is attached to the side of the hoist and the other is led up to and over the single sheave pulley block, after which it is attached to the winding drum.

The air hoist is operated by hand chains and cables passing over fairleads and pulleys. If the chain nearest to the operator is pulled up, the platform rises, allowing the chain to pass through the operator's hand. As soon as the chain is released, compression springs in the air hoist return the controls to neutral and the platform comes to rest. The opposite procedure is carried out when lowering the platform. Adjustable cut-out stops incorporated in the mechanism of the air hoist come into action when the platform reaches the top or bottom of its travel to prevent over-running. Should the air supply to the hoist be cut off the motor stops and its internal brake prevents the cable drum from rotating to hold the platform in position until the air supply is reconnected.

A vertical steel ladder attached to the main frame and extending from the first platform to the top of the structure allows an operator to climb to the main platform should it be required to maintain the platform in some fixed position above its bottom limit. The complete mobile adjustable staging is mounted on lockable castor wheels which are large enough to permit easy man-handling on a flat surface.

[Reply Card No. E2841]



Mobile staging with a platform raised and lowered through cables by a pneumatic motor and developed for servicing aircraft tail units. The 4ft by 18ft platform has a 10 cwt capacity and moves over a height from 15ft to 35ft 6in above floor level

Flowmeters for Liquids

A RANGE of equipments for the measurement of the rate of flow of liquids has been developed by Firth Cleveland Instruments, Ltd., Treforest, Glamorgan, which has its sales and service office at Stornoway House, Cleveland Row, London, S.W.1.

These equipments, known as the series EF1030 turbine flowmeters, are available for flow rates from 0·25 to 10,000 gallons per minute for pressures up to 2000 lb per square inch and temperatures from −200 deg. to 160 deg. Cent.; high-temperature equipments designed for temperatures up to 500 deg. Cent. are also available. The accuracy is stated to be ±0·5 per cent over a flow range of 10 : 1. Viscosities up to 6 centipoises have no appreciable effect on accuracy and the flowmeters are designed to be suitable for industrial fluids such as water, fuel oils, alkalis and some acids.

The flowmeter consists of a non-magnetic pipe-like housing, containing a magnetic, stainless steel, multi-bladed rotor. Outside the pipe section a screw-in magnetic pick-up coil assembly is fitted. When a liquid passes through the meter, the rotor revolves at a speed proportional to the rate of liquid flow. As each rotor blade passes the pick-up coil, the magnetic field generated by the permanent magnet (contained in the coil) induces an alternating voltage across the coil. The frequency of the induced voltage is proportional to the volumetric flow rate, while the total number of pulses generated is proportional to the quantity of liquid metered. The output signal can be fed to instruments indicating respectively the rate of flow or totalised flow.

To give an indication of the flow rate, the electrical pulses are fed to a frequency converter (type EF 1004) giving direct current proportional to frequency and operating a rate-of-flow indicating instrument in the form of a circular milliameter. It has a frequency range of from 5 to 1000 c/s in four switched ranges, with continuous adjustment of the full scale current up to 1mA according to the setting of a frequency-selector switch. A range of circular scale moving coil meters manufactured by Crompton Parkinson, Ltd., has been adopted for use as rate-of-flow indicators. They are available in five dial sizes from 2in to 8in and have knife-edged pointers. If the user wants a permanent record of flow rates an electronic potentiometric recorder (MR 1035) can be connected to the converter.

An electronic scale scaler (ES 1045) and a totaliser unit (E.T. 1046) can be installed to display the total quantity of liquid passed through the flowmeter. The scaler unit is a high-speed variable batching counter. On completion of each batch count, a relay operates and registers a count of one digit on the totaliser unit. The count display is in the form of large clearly visible numbers which are generated by " Digitron " number tubes.

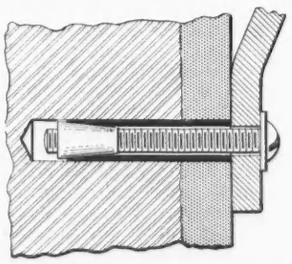
The manufacturer can also supply " density correctors " and the associated electronic equipment to indicate or record the flow rates and totalised flow by weight.

[Reply Card No. E2842]

Wall Plugs

THE drawing below shows a new design of wall plug known as the " Grippo Plug " which has been introduced by Grippo Products, Ltd., Henshaw Works, Oldham, Lancs. These plugs consist of a shell of resin-impregnated paper which is inserted into the hole in the wall and has passing through it the mounting screw. A tapered brass plug on the end of the screw is drawn into the slotted inner end of the shell as the screw is tightened on to the fitting being attached to the wall.

As the inner end of the shell is expanded by the drawing inwards of the brass plug, a firm hold is attained at the lower end of the hole where the surrounding material is strongest. It is claimed that by imparting the holding force at the inner end of a hole friable surface plaster is undamaged and the maximum grip to the strength of the screw is attained. This design of plug is available in four sizes for use in holes bored with No. 8, 10, 12, and 14 drills, the screws in each case being 2in long and the shells 1¼in long. The makers state that these plugs can also be used successfully for fixing light machines or benches to the floor.



Wall plug which imparts the holding force at the inner end of a hole

[Reply Card No. E2843]

Face Milling Cutters

To simplify and speed the accurate replacement of inserted blades in face milling cutters Wickman, Ltd., Tile Hill, Coventry, recently introduced what are termed "Rapid Re-set" milling cutters. This design of cutter simplifies off-hand grinding by the use of a special grinding jig, a gauge, and a setting block.

The grinding jig is clamped on the table of a grinder and enables the cutter blade tip to be accurately ground to the required rakes and clearances, the gauge being used to check the bevel angle. A spring-loaded plunger is set in a bore at the rear end and held with the required length projecting beyond the back face by a retaining screw. After a blade has been ground it is placed in the setting block recess with its cutting edge against a hard face; the retaining screw is released for the spring-loaded plunger to extend and register on a fixed pin at the rear of the block. The plunger retaining screw is then tightened. Using this setting procedure with all the blades of a face milling cutter ensures that they all have precisely the same length between

Blade removed from cutter body; the adjustable locating plunger can be seen projecting from the rear of the blade

the forward cutting edge and the head of the plunger.

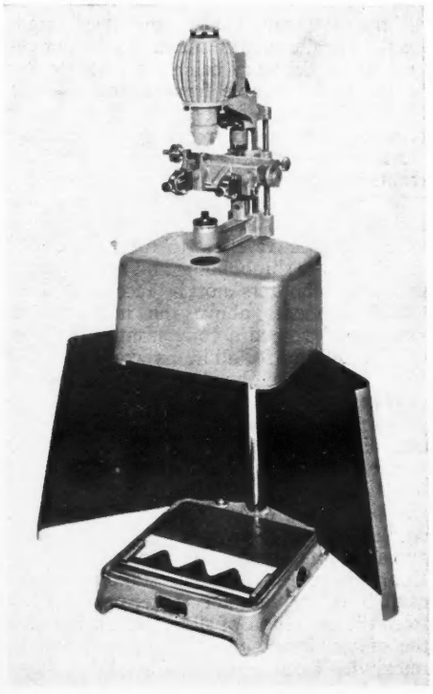
When the blades are then inserted and locked in the cutter body, as shown in the illustration, their correct length of projection is ensured and the cutting angles are similar throughout the set. The three styles of blades available with this system cover milling requirements for a wide variety of materials. These blades all have a bevel angle of 30 deg.; one with a 10 deg. negative helix and 5 deg. negative radial rake, a second with a 20 deg. positive helix and 12 deg. negative radial rake, and the third with zero helix and 5 deg. positive radial rake. Cutter bodies for use with these blades are made in various designs and from 6in to 10in diameter.

[Reply Card No. E2851]

Optical Comparators

THREE designs of optical comparators have been developed by Heston Aircraft and Associated Engineers, Ltd., Heston Airport, Hounslow, Middlesex, for use on the work bench, in the inspection department and the tool room or standards room respectively. The "Heliscope" for work bench use is a straightforward direct-projection optical comparator provided with three sets of object lenses giving magnification powers of ×10, ×25 and ×50, for which the respective field diameters are 1·2in, 0·5in and 0·25in. The use of achromatic lenses eliminates colour aberrations from the light source, and green filters are built into the condensers to obviate eyestrain. Illumination is given by a 12V 100W lamp operating from mains supply through an integral transformer.

The base-plate, of machined, close-grain cast iron supported on adjustable feet, is fitted with a tubular steel column carrying the object-lens arm, the work-mount structure and the lamphouse



Workbench comparator with three sets of object lenses of ×10, 25 and 50 magnifications

assembly. As can be seen in the illustration, a sheet-metal shroud is fitted for light exclusion, and it has hinged side panels which give free access and facilitate adjustment of templates on the viewing base. The optical and work-mount head assembly comprises a series of castings attached to the upper part of the main column, the object-lens arm and the lamphouse anchor casting being screwed to the column and joined by subsidiary tubular struts one on each side of the column. Midway between object lens and lamphouse, the work-mount assembly slides vertically on the main column (the subsidiary struts locating it radially) with rack and pinion control of its position over a height of 3in. The root casting of the work-mount is a yoke spanned by a ground square-section bar. A leadscrew in the left lug of the yoke controls 1·437in lateral movement of a second casting mounted on the square bar, and from this casting two short rods project forward to carry a third casting, the 1½in fore and aft movement of which is controlled by a central rack and pinion. On this third casting the various work-holding fixtures are attached.

The lamphouse is mounted on a baseplate at the head of a tubular strut which has its foot pin-jointed to the object-lens arm coincident with the optical centre of the system. A curved rack and pinion on the lamphouse baseplate control angular movement of the lamphouse assembly about the optical centre.

The "Vertex" comparator is a reflex version of the "Heliscope" which has greater projection power and with its etched glass screen enables more than one viewer to study the projected image.

The "Revelation" comparator for use in tool rooms or standard rooms is also illustrated on this page and it is an epidiascope as well as a profile projector. These two functions can be used in combination to permit profile and surface examination of the walls and bases of holes up to 3in deep. The instrument provides four powers of magnification, ×10, 25, 50 and 100, in conjunction with respective field diameters of 1·2in, 0·5in, 0·25in and 0·12in.

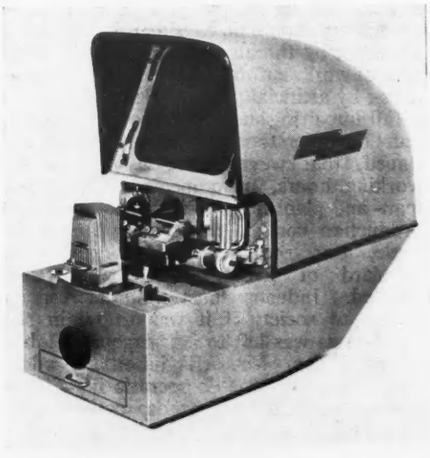
The optical system is such that sensibly constant light intensity is maintained across the whole section of the parallel beam, the illumination being given by special-filament 100W lamps operating at 12V alternating current from mains supply through an integral transformer.

The compound worktable is made to close tolerances, and is equipped with a large diameter drum micrometer for purposes of adjustment and accurate measurement in traverse.

The lamphouse for profile projection is mounted centrally toward the front of the base table, with the lamphouses for surface and deep-hole projection one each side of the instrument beneath the viewing screen. The 8½in by 3½in compound worktable is placed centrally within the triangle of lamp locations, its height being controlled over a distance of 2½in by a knurled wheel on the front of the base table. Table fore and aft movement (focusing) over 2½in is controlled by a knurled spindle-head projecting to the left of the table and lateral movement is controlled by a micrometer drum to the right of the table.

The 13in by 12in viewing screen of fine-texture etched glass has four spring-steel pivoted fingers for clamping templates. For inspection work entailing the accurate assessment of angular relationships, a 360 deg. protractor can be fitted in place of the normal viewing screen. This protractor has an etched glass screen with vertical and horizontal cross-wires commonly centred with 30 deg. graticule lines. A vernier adjustment is embodied at the base of the rim, and the accuracy of angular division is stated to be two minutes of arc.

[Reply Card No. E2852]



Tool room or standards room comparator with four magnifications of ×10, 25, 50 and 100 and combining the functions of an epidiascope and projector

Launches and Trial Trips

ATHELQUEEN, oil tanker; built by Barclay, Curle and Co., Ltd., for the Athel Line, Ltd.; length 560ft, breadth 71ft 9in, depth 40ft 6in, deadweight 19,800 tons; nine cargo tanks, two cargo pump rooms; four 150kW generators, three diesel driven and one steam driven; Barclay Curle—Doxford oil engine, six cylinders, 750mm diameter by 2500mm combined stroke. Trial, June 2.

ROTHESAY CASTLE, refrigerated cargo liner; built by the Greenock Dockyard Company, Ltd., for the Union Castle Mail Steamship Company, Ltd.; length between perpendiculars 480ft, breadth moulded 65ft 9in, depth moulded to upper deck 37ft 10½in, gross tonnage 9500, deadweight 10,000 tons, refrigerated capacity 450,000 cubic feet; service speed 16¼ knots; Kincaid diesel engine, six cylinders 750mm diameter by 2000mm combined stroke, 8600 b.h.p. at 112·5 r.p.m. Trial, June.

TRESFONN, bulk carrier; built at Belfast by Harland and Wolff, Ltd., for Skibsaktieselskapet Dulfonn, Norway; length between perpendiculars 520ft, breadth moulded 70ft, depth 42ft 9in, deadweight 19,000 tons; seven cargo holds, wing ballast tanks; hydraulically-operated windlass, cargo winches and self-tensioning winches; three 200kW diesel-driven generators; Harland and Wolff oil engine, five cylinders, 750mm diameter by 2000mm combined stroke. Trial, June 13.

INDUSTRIAL NEWS

Machine Tools

The monthly report on new orders for metalworking machine tools issued by the Machine Tool Trades Association shows that, although there was a slight slackening of new orders during May last compared with earlier in the year, there was a net increase of 66 per cent on the orders placed during May, 1959. During May last 5368 new machines were delivered to home buyers and 1722 to overseas countries. Orders in hand for home users at the end of May totalled 63,570 machines and 20,046 orders were in hand for export, the net new orders placed were for 10,176 machines for this country and 2202 for overseas. These figures are based upon returns from firms accounting for about three-quarters of total deliveries and include estimates from smaller firms making only quarterly or annual returns.

In the first five months of this year the net new orders received for machine tools were 125 per cent more than last year, and it is stated that the value of machines delivered during May was 7 per cent higher than in May, 1959.

Employment

The latest figures issued by the Ministry of Labour show that during June, the number of people in civil employment is estimated to have increased by 70,000 to 23,593,000 (15,478,000 men and 8,115,000 women), the highest figure ever recorded in Great Britain. In the engineering and electrical goods group the number employed increased by 4000 to a total of 2,056,000, compared with 1,938,000 at the end of June, 1959. The number of people employed in the metal manufacturing industry increased by 2000 to 620,000, and in metal goods manufacture by 1000 to 551,000. On the other hand, the number of people employed in shipbuilding and marine engineering decreased by 3000 to 252,000, 12,000 less than a year earlier. Outside of the manufacturing industries, 5000 more people were employed on construction work in June and 5000 more in the transport and communication services, but in mining and quarrying 6000 fewer people were employed, bringing the total down to 765,000, compared with 826,000 a year earlier.

The number of operatives working short-time in manufacturing industries in the week ending June 25 was 29,700, states the Ministry of Labour, which was 1100 fewer than at the end of May.

Wages and Hours

Changes in rates of wages and hours of work reported to the Ministry of Labour as having come into operation during June are estimated to have resulted in about 737,000 workpeople receiving an aggregate increase of approximately £279,000 in their full-time weekly rates of wages, and 28,500 workpeople a decrease of £3500, whilst 181,000 workpeople had their normal weekly hours reduced by an average of nearly 1¾ hours. The most recent statistics published by the Ministry show that one of the principal increases in wage rates affected British Railways staff. A final settlement for British Railways staff following the report of the Railway Pay Committee Inquiry resulted in the interim increase of 5 per cent granted in February being increased to 8 or 10 per cent, payable from January 4, with further increases of broadly 5 or 10 per cent for certain senior grades. Non-skilled workers in Government industrial establishments in Great Britain paid at miscellaneous "M" rates received increases of 2s. a week for men and 1s. 8d. for women, authorised with retrospective effect to the beginning of April. In the shipbuilding and ship-repairing industry, labourers not in receipt of additional payments above the national time rates were granted a compensatory payment of 1¾d. an hour for all hours worked (6s 1½d. for a forty-two hour week); additional payments below this amount qualifying for proportional compensation to secure equivalent minimum rates.

The Ministry of Labour says that of the total increase of £279,000, about £251,000 resulted from direct negotiations between employers and trade unions; £20,000 from arrangements made by Joint Industrial Councils or other joint standing bodies established by voluntary agreement; £4000 from the operation of sliding scales based on the official index of retail prices; and the remainder from orders made under Wages Councils Acts.

Wages and Industrial Relations

The sixty-first annual general meeting of Edgar Allen and Co., Ltd., was held at Imperial Steel Works, Sheffield, on July 28. In his statement, circulated to all shareholders, Mr. W. H. Higginbotham, chairman of the company, said there was impending a new round of demands for wage increases and a fairer share of allegedly disproportionately increased industrial profits: these, based on an improvement in the national "productivity index" which—expressed as output per man employed—ignored the great contribution made by progressive capital investment in recent years, and the inescapable fact that process plant might well have greater influence on output than that of the labour which attended it. These claims, the chairman said, would almost certainly be supported by the usual militant speeches (from too many of which the most elementary economic considerations would be absent); by threats of—and actual—stoppages of work, enforcement of restrictive practices; by artificially created labour shortages—(all impairing stability and confidence). It must be understood, Mr. Higginbotham continued, that wages increases and shorter working hours, uncompensated by greater man- and plant-hour efficiency must increase production costs; that thereby our export trade, our economic stability and our standard of living might be adversely affected. Industry must fulfil its responsibilities to society if it was to retain such freedom as was left to it; organised labour in particular, Mr. Higginbotham added, must recognise that democratic institutions, such as trade unions (whose activities and privileged positions were at present so anomalous) must have competent elected leadership, and that their members must be prepared to accept the reasonable disciplines necessary to give effect to that leadership in discharge of their social responsibilities. The pursuit of their own personal or sectional interests without regard to those of others was no longer tolerable.

Export Credits Guarantee Department

The Export Credits Guarantee Department announces that business declared under its "commercial" insurances during the second quarter of 1960 was a record for this quarter, though below the all-time record of the previous quarter. The gross value of all short-term and medium-term insured business (including external trade) declared as shipped during the quarter amounted to £161,000,000 compared with £178,900,000 in the previous quarter and £155,200,000 in the second quarter of 1959.

The number of short-term policies current at the end of the second quarter of 1960 was 4996 compared with 4920 at the beginning of the quarter and 4669 at the end of the corresponding quarter last year. The face value of short-term policies current at the end of the quarter was £673,600,000, compared with £650,900,000 at the beginning of the quarter and £631,600,000 at the end of the second quarter of 1959. New medium-term business to the face value of £39,300,000 was transacted during the quarter, the Department states, compared with £20,200,000 in the first quarter of 1960 and £34,000,000 in the corresponding quarter last year.

Miners' Wages

The National Coal Board announced on Monday of this week that the National Reference Tribunal for the Coal Mining Industry had issued its award relating to a claim by the National Union of Mineworkers for an increase of 2s. a shift (12s. a week) in national standard grade rates for day-wage men. The Tribunal has awarded an increase of 10d. a shift (5s. a week) to take effect from the first full week after September 1. The award refers to a recent claim for reduced working hours with which the Tribunal dealt separately and goes on to state that it was, however, then recognised that if by the time of the subsequent hearing of a wages claim the hours claim had been adjudicated upon, the effect of the decision in the hours claim would be a factor which would be before the Tribunal and which it would have in mind.

It was announced on July 13 that the National Reference Tribunal had awarded that underground hours should be reduced by one hour a week, and had left it to the National Coal Board and the National Union of Mineworkers to agree on the best arrangement to give effect to that reduction. (THE ENGINEER, July 22).

Import and Export Prices

Recent statistics issued by the Board of Trade show that after remaining constant during the past three months the index of import prices dropped one point in June to 98 (1954=100). As the export price index remained at 111, the terms of trade improved one point to 88. Falls in the price index number for imported fuels and manufactured goods were the main reason for the small overall fall in the total import price index.

PERSONAL AND BUSINESS

Appointments

MR. RALPH HUSSEY has been appointed a member of the board of directors of James Gordon and Co., Ltd.

MR. H. ROY THIELÉ has been appointed as deputy to the advertising manager of the Morgan Crucible Company, Ltd.

MR. B. J. STORRAR has been appointed sales manager of Edwin Cooper and Co., Ltd., a member of the Castrol Group of Companies.

MR. J. E. YATES has been appointed general sales manager of Lancashire Dynamo and Crypto, Ltd., a company in the Metal Industries Group.

MR. R. A. S. LOMAX has been appointed chairman of the Council of Ironfoundry Associations' training committee in succession to Mr. Kenneth N. Davis.

THE NATIONAL COAL BOARD announces that Mr. R. F. Lansdown has been appointed director of its Central Engineering Establishment at Bretby, South Derbyshire. Mr. Lansdown has been the Board's chief mechanisation engineer since January, 1956.

THE COUNCIL OF BRITISH MANUFACTURERS OF PETROLEUM EQUIPMENT states that Mr. J. M. Storey has taken up office as chairman of the Council in place of Mr. G. H. Thorne, who becomes immediate past chairman and chairman of British Oil Equipment Credits, Ltd.

MR. ADRIAN LIDDELL HART has been appointed an assistant director of the Society of British Aircraft Constructors. He will be specially concerned with economic and political trends, helping to formulate Society policy, and with the Society's external relations.

VISCOUNT FALMOUTH, M.I.Mech.E., has been re-elected President of the British Internal Combustion Engine Research Association. Professor S. J. Davies has been elected a vice-president and Mr. G. Blackith and Mr. S. J. Wood are newly-elected members of the council.

THE GOODYEAR TYRE AND RUBBER COMPANY (GT. BRITAIN), Ltd., announces that Mr. W. U. Chapman has been transferred to the export sales division of the company, and has been succeeded as manager of Goodyear industrial products department by Mr. J. T. Pearson.

MR. J. I. HUNT has been appointed works manager and Mr. A. Dean, assistant works manager, of Thomas Smith and Sons (Rodley), Ltd. These appointments follow the retirement, from the position of works manager, of Mr. David Keighley, who has spent forty-five years in the company's service.

MR. D. A. F. DONALD, chairman and managing director of National Cash Register Company, Ltd., has been appointed chairman of G. A. Harvey and Co. (London), Ltd. He succeeds Sir Thomas Overy, who has relinquished the chairmanship on medical advice but who remains a director of the company.

BRITISH AIRCRAFT CORPORATION, Ltd., announces that Mr. Charles Gardner has been appointed as the Corporation's publicity manager. Mr. Robert J. Blackburn has been appointed sales publicity manager, Vickers-Armstrongs (Aircraft), Ltd., and Mr. John H. Motum, deputy sales publicity manager.

THE BRITISH BROADCASTING CORPORATION has announced the appointment of Mr. P. E. F. A. West, A.M.I.E.E., as regional engineer, Western Region, in succession to Mr. G. H. Daly who is retiring. Mr. H. G. Whiting, A.M.I.E.E., has been appointed regional engineer, Midland Region, in succession to Mr. W. A. Roberts, M.I.E.E., who becomes the region's administrative officer.

THE WORKINGTON IRON AND STEEL COMPANY, branch of the United Steel Companies, Ltd., has announced the following appointments: Mr. G. Pott, chief engineer; Mr. W. Hunter, iron works superintendent, with responsibility for ore preparation and blast furnaces: Mr. F. Greenhalgh, blast-furnace manager; Mr. J. D. Young, assistant steel-works superintendent, and Mr. G. Forster, Bessemer manager.

MR. H. M. HENDERSON has been appointed director and general manager of the Workington Iron and Steel Company branch of The United Steel Companies, Ltd. At present, he is managing director of Unisteel Structural (Pty.), Ltd., Cape Town, and will take up his new appointment in November. Mr. T. Sanderson has been appointed deputy general manager of Workington Iron and Steel Company and is succeeded as director and general works manager by Mr. H. Darnell.

K.M.T. (HOLDINGS), Ltd., has appointed Mr. V. G. Eyre managing director of Monks and Crane, Ltd., and Mr. S. B. Jackson of Qualcut Tools, Ltd., to its board of directors. Both companies are group members of K.M.T. (Holdings), Ltd. Mr. D. W. Thomas has resigned from the board of Monks and Crane, Ltd., in order to devote more time to other interests within K.M.T. (Holdings), Ltd. Mr. F. Naylor has been appointed managing director of Qualcut Tools, Ltd. K.M.T. (Holdings), Ltd., has appointed Mr. J. W. Nicholls as a director of Broadway Aircraft Engineering Company, Ltd.

THE DAVID BROWN CORPORATION has announced the appointment as follows, of directors of two of its re-formed product groups: David Brown Tractors, Ltd., parent company of the tractor and agricultural machinery group; Mr. David Brown (chairman and joint managing director), Mr. David Brown, junior (joint managing director), Mr. J. Thompson (general manager), Mr. L. V. Gallagher (manufacturing), and Mr. J. D. Elstone (marketing); Aston Martin Lagonda, Ltd., parent company of the automobile group; Mr. David Brown (chairman and managing director), Mr. J. Wyer (general manager), Mr. David Brown, junior, Mr. J. Thompson and Mr. J. Stirling.

DU PONT DE NEMOURS INTERNATIONAL S.A. announces that Dr. Russell A. Kurtz has been appointed marketing manager for neoprene synthetic rubber and other synthetic rubber products. He will be responsible for directing elastomer sales activity in Europe, Africa and Australasia, working from Geneva. He has succeeded Mr. Samuel W. McCune who is general sales manager of the Du Pont Company (United Kingdom), Ltd. Mr. Robert H. Walsh has been appointed assistant marketing manager and will also move to Geneva. Dr. Hans Horn has been appointed promotion manager and will co-ordinate promotion, product information and advertising activities from Geneva.

MR. G. E. SMITH, director of production for the Perkins Group, has accepted an appointment as assistant managing director of the Hamworthy Engineering Company, Ltd. He relinquishes his appointment with the Perkins Group on September 12. Mr. T. H. R. Perkins, managing director of Perkins Engines, Ltd., will act as director of production and will assume full responsibility from Mr. Smith on September 12. This is a temporary appointment. From this date Mr. J. M. Collins, export sales manager of Perkins Engines, Ltd., will become acting director of marketing for the Perkins Group of companies, and Mr. Perkins will temporarily relinquish his responsibility for all marketing activities within the Perkins Group.

Business Announcements

ALLSPEEDS, Ltd., has moved its head office and factory to Royal Works, Atlas Street, Clayton-le-Moors near Accrington. This new establishment has a floor area of over 120,000 square feet.

SIR WILLIS JACKSON, F.R.S., director of research and education of Associated Electrical Industries (Manchester), Ltd., is to return to academic life as professor of electrical engineering at Imperial College, University of London, in October, 1961.

CAUSEWAY REINFORCEMENT, Ltd., Five Ash Works, Dover Road East, Northfleet, Kent, has announced the formation of a new installation division. Mr. J. D. Abernethy, has been appointed manager of the new division.

G. AND J. WEIR, Ltd., Cathcart, Glasgow, S.4, states that it has arranged to acquire the complete compressor business of Alley and MacLellan (Polmadie), Ltd. Within the next six months the production of "Alley" units will be transferred from Polmadie to the Cathcart Works of G. and J. Weir, Ltd.

FAIRBANKS MORSE AND CO., E.M.I. House, Manchester Square, London, W.1., a subsidiary of the Fairbanks Whitney Corporation of New York, has established an electronics division to co-ordinate the company's present domestic engineering, manufacturing and sales activities in this field, and the marketing of British products manufactured by E.M.I. Electronics, Ltd.

THE PERMUTIT COMPANY, Ltd., Permutit House, Gunnersbury Avenue, London, W.4, and the UBS CHEMICAL COMPANY, of Cambridge, Mass., a division of the A.E. Stanley Manufacturing Company of Decatur, Ill., have announced a joint venture for production and distribution of "Ubatol" brand polymer emulsions overseas. The synthetic polymer products will be produced at Permutit's chemical works in Glamorgan.

HUNTINGTON, HERBERLEIN AND CO., Ltd., are to build a special sinter plant to be used for research work on new low shaft blast-furnace techniques for La Comité Internationale de Récherche Métallurgique at Liège, Belgium. The plant will be a complete installation in miniature, with an output of 10 tons per hour of finished sinter.

CAMBRIDGE INSTRUMENT COMPANY, Ltd., states that its merger with Electronic Instruments, Ltd., has now been completed. Mr. Paul Goudime, managing director of Electronic Instruments, Ltd., has joined the board of Cambridge Instrument Company, Ltd. Dr. P. Dunsheath, Mr. H. C. Pritchard and Mr. W. E. Lamb, of Cambridge Instrument Company, Ltd., have joined the board of Electronic Instruments, Ltd.

Contracts

PLATT BROTHERS (SALES), Ltd. (a subsidiary of Stone-Platt Industries, Ltd.), has secured a contract from the U.S.S.R., totalling approximately £1,750,000, for a complete "New Continental" worsted spinning plant to be supplied by Prince-Smith and Stells, Ltd., Keighley. In addition, the contract covers worsted finishing machinery and units of cotton spinning machinery.

HOLLOWAY BROTHERS (LONDON), Ltd., has received a contract worth £500,000 for ore and coke stockyard foundations at the Spencer Works of Richard Thomas and Baldwins, Ltd. To suit local ground conditions and the method of stocking, caissons are being used, and 120 caissons will have to be completed in twenty weeks to meet the plant construction schedule. W. S. Atkins and Partners are the consulting engineers.

STEWARTS AND LLOYDS, Ltd., has received an order worth more than £900,000 for seamless steel tubes for a 280-mile oil products pipeline from Shahrud to Meshed in Iran. The pipeline marks the second stage of a 516-mile line from Tehran to Meshed. Work on the first stage, the 236 miles from Tehran to Shahrud, for which Stewarts and Lloyds, Ltd., supplied pipe worth more than £800,000, is nearing completion. Both orders were placed by Willbros (Overseas), Ltd.

THE CEMENTATION COMPANY (AFRICA) (PTY.), Ltd., has received a contract for tunnelling the "Twelve Apostles," part of the Table Mountain range. Carrying water from the Hely Hutchinson and Woodhead reservoirs on Table Mountain, the tunnel, which is to be 4300ft long, will supply the Kloof Nek filtration plant. The new tunnel will be 6ft 6in high with an arched roof, and 6ft 6in wide. The contract time is 600 days and the drive should be through at Disa Gorge early in 1961.

ASSOCIATED ELECTRICAL INDUSTRIES (N.Z.), Ltd., has received an order from the New Zealand Government Railways for twenty sets of power equipment, including diesel engines, for 420 h.p. diesel-electric shunting and light service B_0-B_0 locomotives. The locomotives, to be built in the railways' workshops, will be very similar to the eighteen locomotives supplied by A.E.I. in 1959, which had mechanical parts by the Clayton Equipment Company Ltd., and Rolls-Royce diesel engines. The diesel engines (two in each locomotive) for the new series will be manufactured by British United Traction, Ltd.

JOHN THOMPSON, Ltd., of Ettingshall, Wolverhampton, has signed an agreement with the Indian Sugar and General Engineering Corporation, Ltd., for the erection at the Punjab works of the corporation of a new plate shop capable of carrying out welding to Class I specifications. The aim throughout the negotiations leading to the agreement between the two companies has been to discover how best typical products of John Thompson, Ltd., can be fabricated at the "Isgec" works. To this end, the British firm will supply £75,000 worth of equipment while machinery worth over £200,000 will be contributed by the Indian Company.

Deaths

WE have learned with regret of the death on July 27 of Mr. A. H. Dack, one of the founder members of the Institute of Road Transport Engineers. He was fifty-seven. Mr. Dack served on the formation Council of the Institute in 1944-45, and continued to serve on all successive Councils without a break until his death. During the whole of the period from 1945 to 1960 he was the honorary treasurer of the Institute and played a major part in shaping the Institute's financial policies. Mr. Dack was chief engineer of the Union Cartage Company's South London depots from 1938 until his death.

Indian Engineering News

By OUR INDIAN CORRESPONDENT

First Decade of India's Planned Economy

It is opportune to strike a balance sheet for the first decade of India's planned economy. In the first Plan (1951–56) the emphasis was on agriculture and Community Development, irrigation and power, transport and communications. The rehabilitation of railways which had suffered on account of the second world war and partition of the sub-continent formed one of the main objectives of this period. It also witnessed the fruition of a new domestic oil refining industry. In the second Plan (1956–61) the accent is on heavy industry (steel, coal, cement, &c.) to meet, in the words of Prime Minister Nehru, " the physical needs of the people." The total investment during the first two Plans has been Rs.10,110 crores, the public sector alone accounting for Rs.6,560 crores. The increase in production over the period (1951–61) is estimated at 120 per cent in the industrial sector.

Approximately 1300 miles of new railway lines are likely to be added, 1300 miles of railway track doubled, and 880 miles electrified by 1960–61. The total freight traffic originating on the railways is expected to increase by 80 per cent from 91,000,000 tons to 162 million tons. The number of locomotives will go up from 8200 to 10,600 ; coaches from 19,200 to 28,900, and wagons from 199,100 to 354,100. The mileage of surfaced roads will be 144,000 miles in 1960–61, an increase of 46,500 miles on 1950–51 ; and the number of commercial vehicles will rise by 100 per cent, reaching 20,000 in 1961. The shipping tonnage will go up from 390,000 g.r.t. to 900,000 g.r.t. during the decade. There will be an increase of 20,000,000 acres in the irrigated area, and 3,500,000kW in power generation capacity.

Industrial development shows progress in basic, capital and producer goods sections, especially machinery and engineering industries. The aggregate value of all kinds of machinery produced rose in value from Rs.11 crores in 1951 to Rs.79 crores in 1958. By 1961 much of the equipment required by the railways will be available from indigenous production. A beginning has been made in the manufacture of heavy electrical equipment and chemicals including drugs, pharmaceuticals and fertilisers. In a number of cases of domestic manufacturers the import component has been reduced. There has been a substantial growth in the production of cycles and automobiles. The manufacture of several new products was established in India for the first time including industrial boilers, milling machines and other types of machine tools, industrial explosives, sulpha and antibiotic drugs, D.D.T. and newsprint. Close on sixty industrial estates comprising 700 small factories will have been set up by 1961. Lastly, the annual intake of students in degree and diploma courses in engineering and technology courses is expected to increase by 375 per cent, from 10,000 in 1950–51 to 37,500 in 1960–61. However, there has been a steep rise in prices, the index of wholesale prices rose from 99 to 118 ; there has been a failure of new employment outlets to keep pace with the growth in labour force (only some 6,500,000 additional jobs were found outside agriculture in place of the goal of 8,000,000 set for 1960–61) ; and house building has lagged.

India's Third Five-Year Plan

One of the principal objectives of India's Third Five-Year Plan (1961–66), the draft of which was published in July, is to secure a marked advance towards self-sustaining growth. This implies that savings and investment in the economy rise sufficiently to secure a high rate of growth income on a continuing basis. An important aspect of this problem is that of creating within the country the capacity to produce the capital goods and equipment necessary to support the scale of investment proposed. So far as India is concerned such self-sustaining growth can only be achieved by balanced development both in agriculture and industry. During 1961–66 the public sector outlay in large-scale industry and mineral development will be Rs.1500 crores and the private sector investment is expected to be Rs.1000 crores. The accent is upon steel, machine building and the production of consumer goods.

Developments in iron and steel industry are linked with the capacity target of 10,200,000 tons in terms of steel ingots, and 1,500,000 tons of pig iron for sale. Proposals for machinery and engineering industries during the Third Plan period include a heavy machine building plant, a foundry forge, a coal-mining machinery plant, a heavy machine tool factory, doubling the output of Hindustan Machine Tools (Bangalore), expansion of the Heavy Electrical Project (Bhopal), two additional heavy electrical projects, and a scheme for the production of high-pressure boilers and precision instruments. Machinery manufacturing programmes in the private sector are reckoned to supplement to a substantial extent the efforts of the public sector. Near self-sufficiency is envisaged in regard to textile, sugar, cement and paper machinery. The production of nitrogenous fertilisers is to be stepped up from 210,000 to 1,000,000 tons in terms of nitrogen, and phosphatic fertilisers from 70,000 to 450,000 tons. On the basis of present reserves the Nahorkatiya area in Assam is expected to produce 2,750,000 tons of crude oil a year. Provision has been made both for the completion of refineries at Nunmati and Barauni to process the Assam oil, and also for further exploration with a view to obtaining additional output of petroleum from Cambay and other areas where prospects are favourable.

Among other important industrial targets to be achieved in 1965–66 are aluminium 75,000 tons, cement 13,000,000 tons, paper 700,000 tons, sulphuric acid 1,250,000 tons, caustic soda 340,000 tons, sugar 3,000,000 tons, cotton textiles (mill cloth) 5800 million yards, bicycles (in the organised sector only) 2,000,000, sewing machines 450,000 and automobiles 100,000. Turning now to power the total generating capacity is to go up from 5,800,000kW to 11,800,000kW. The railways will be able to carry goods traffic totalling 235 million tons in 1965–66 against 162 million tons in 1960–61. Also, 1200 miles of new railway lines are to be constructed. Under the road development programme the length of surfaced roads will go up from 144,000 to 164,000 miles, and the number of commercial vehicles from 20,000 to 30,000. The shipping target proposes to add about 200,000 g.r.t. to the tonnage of 900,000 g.r.t. expected to be achieved at the end of the Second Plan. Finally, the admission capacity of engineering colleges and polytechnics will increase from 37,500 in 1960–61 to 53,000 at the end of the Third Plan period.

Manufacture of Heavy Electric Equipment

A heavy electrical factory at Bhopal, said to be the first of its kind in India, commenced production on July 1 according to schedule. For a start it is to manufacture switchgear control panels, power transformers and capacitors of small sizes, and is planned progressively to cover bigger ranges as the workers and technicians acquire experience and proficiency. Thus traction motors for the railways are to be turned out from April, 1962. Equipment for electric locomotives and industrial motors will follow, and hydro and thermal generators are to be made about a year later. By 1967 or so when the factory is in full production it is planned to turn out annually hydro and thermal generating units aggregating 1,000,000kW capacity, the maximum single unit being of 150,000kW. The factory block for the first phase of the project has been completed. A well-equipped laboratory for testing and research is being got ready. A modern township with all amenities has arisen in the area with some 3000 quarters ready for occupation.

Following the visit to India of Viscount Chandos, chairman of Associated Electrical Industries, Ltd., early this year, a four-fold expansion of the Bhopal heavy electrical plant was decided upon. This programme is reckoned to take virtually a decade for completion. It was originally envisaged that the project would account for Rs. 12.5 crores worth of electrical machinery operating on a single shift basis. The first stage of expansion due for completion in the next five or six years would enable this factory to produce Rs.25 crores worth of equipment on a double shift working. Out of the total cost of £85,000,000 for expansion the cost of fixed assets would total £47,000,000 and the foreign exchange component would be of the order of £18,000,000. Lord Chandos affirmed that A.E.I. would be prepared to arrange for sterling finance for this amount or any part of it the Indian Government wants. Even for the existing Bhopal project A.E.I. as consultants have arranged sterling credit to pay for capital equipment to be imported.

A school at Bhopal training technicians to man the plant is, perhaps, the largest training institution in the world. There were 2700 trainees here at the beginning of this year, and when the expansion programme is completed there will be 32,000 trained men. The training shops have been equipped, according to Lord Chandos, with " first-class machine tools made in India." In addition, A.E.I. had ninety Indian engineers undergoing training in its British factories and workshops in 1959. Lord Chandos added that " we have formed a high opinion of their technical abilities. What is more important, however, is that the happiest personal relations have been established with them. Upon their shoulders will rest the responsibility for the future success of this heavy electrical project." In this context it is worth recalling that the total installed capacity for power generation in India in 1960–61 (the final year of the second Plan) will be 5,800,000kW, the additional capacity erected during the Plan period being 2,400,000kW. Also, nearly 35,000 miles of high voltage transmission lines and transformers will have been completed by them. Additional installed capacity to be created in the third Plan period (1961–66) will be approximately 6,000,000kW.

Research and Isotopes Production Reactor goes Critical

What is believed to be the world's largest research and isotopes production reactor, the Canada-India Reactor, situated in Bombay, went critical early in July, 1960. Built at a cost of Rs.10 crores it is a symbol of the co-operation between the two Commonwealth countries in the field of research. In this joint Indo-Canadian enterprise Canada's share of Rs.3.56 crores was provided under the aegis of the Colombo Plan. This reactor is the first major atomic energy project to be undertaken in the realm of international assistance. Work on the undertaking was started in 1958. In it India has one of the best isotope producers in the world. With it the country will be able to account for the full range of radioactive isotopes. This reactor will require nearly 20 tons of heavy water which has been sold to India by the U.S. Atomic Energy Commission.

Machine Tool Production

The annual report of the State-owned Hindustan Machine Tools (H.M.T.) factory for the year ended March 31 last makes heartening reading. During this period the factory turned out 702 machines worth Rs. 2.8 crores against a target of 314 machines. The previous year's production was 552 machines. In 1959–60 the H.M.T. sold 1020 machines, and received 1222 orders. The latter indicate that 45 per cent came from private customers, 35 per cent from Government corporations, 11 per cent from State Governments and 9 per cent from the

Government of India including railways. Under its diversification programme the factory is now in a position to produce ninety types of machine tools.

Mr. M. K. Mathulla, managing director, stated that the H.M.T. is to make a " gift to the nation of another factory of the same dimensions out of its own resources without the assistance of the Government of India." With the expansion programme costing Rs.2.87 crores (of which Rs.1.14 crores would be foreign exchange expenditure) the factory would be able to double its production from 1000 to 2000 machines a year. The H.M.T. has been able to build adequate financial resources during its four-year period of operation which are to be ploughed back into the expansion scheme. In terms of value the annual output of the factory after doubling its capacity will be approximately Rs.7 crores with the share capital remaining at Rs.5.31 crores as at present. The expansion programme is to be completed within two years against the seven years taken for the commissioning of the original factory. Mr. Mathulla added that during the third Plan period (1961–66) the H.M.T. might be converted into a corporation with two more machine tool plants being put under its management. The question of reviving the scheme of workers' participation in management which was tried in this factory for a time and ceased to function early in 1959 would be taken up after the representative character of the two existing rival trade unions has been decided.

Australian Engineering News

By OUR AUSTRALIAN CORRESPONDENT

Water and Australia

In his recent presidential address to the Institution of Engineers, Australia, Mr. H. G. Furphy touched on one of the problems facing the Engineers of the future, namely to maintain a supply of water for the rapidly expanding needs of the world's " exploding population," and in particular Australia.

In 1953 water storages in the United States totalled 13 per cent of the country's river flow, or 190 million acre feet. With an estimated doubling of the requirement for water every twenty-five years, by A.D. 2028 the requirement will exceed the total river flow in that country.

Present population trends indicate that Australia could have 55,000,000 people in A.D. 2060, and besides requiring a redistribution of population density, to utilise areas such as North Queensland, where there is a plentiful water supply, would require drastic action in present population centres to avoid water famine.

Ground water supplies have only a limited development potential, and Mr. Furphy considers that the re-use of polluted water will become necessary in Australia, despite aesthetic objections, and points to current practice in densely populated areas of the world, and especially the Ruhr River in Germany, where at times only the return of sewage to the river maintains the water supply.

Providing that objectionable trade wastes can be eliminated, " relaundering " ten or eleven times would be possible before the sodium chloride could be tasted, and theoretically a community could exist almost indefinitely with a relatively small ingress of fresh-water, which could be provided by collecting and laundering storm water. The added health hazard from infectious diseases is unlikely to be more than that currently accepted in public swimming pools.

Demineralising and pumping of sea-water, despite the possibilities of using nuclear energy, is likely to be of serious use only to the coastal regions of Australia. The great distances involved in pumping would be a drawback, but more use could be made of sea-water for industrial and limited domestic use, thus conserving the fresh-water for use by an increased population.

Recent developments in rain-making indicate that precipitation can be accelerated from suitable clouds, sprayed with silver iodide, but not whether total precipitation from the cloud is increased, and there has been no success in causing precipitation from other types of clouds. The Council for Scientific and Industrial Research has claimed increases in precipitation of up to 15 per cent over a 1000 square mile test area in the Snowy Mountains, but this figure is disputed by the Snowy Mountains Hydro-Electric Authority.

Wastage from reservoirs is currently under examination, and while soakage losses are small, evaporation losses can be considerable, particularly as high evaporation rates occur in areas of low rainfall. Experiments have shown that a mono-molecular film of Cetyl Alcohol over the surface of a reservoir reduces evaporation by up to 30 per cent, where surface areas are small enough to prevent wave action breaking the film. The " Mansfield " process, as well as reducing evaporation, permits the absorption of sufficient oxygen into the surface to prevent the water from becoming stagnant.

Much of the western world's recent increase in the use of potable water is in cooling systems. Mr. Furphy considers that salt water or air cooling must be substituted.

Although importation of polar ice from the Antarctic Continent by towing icebergs seems a technical possibility, economics are more likely to lead to settlement in Antarctica by certain industries whose fresh water requirements cannot otherwise be met. Similarly the otherwise unattractive north of Queensland could use its seasonal floods to lure industrial pioneers.

Construction of 210ft Radio Telescope for Australian C.S.I.R.O.

Construction is proceeding near Parkes, in the central west of New South Wales, of what will be the largest radio telescope in the Southern Hemisphere, for astronomical studies by the Radiophysics Division of the Council for Scientific and Industrial Research Organization.

The site specifications called for low wind conditions and an anticipated low level of electrical noise for at least the next twenty years. These conditions could not readily be met east of the Great Dividing Range, and at the site chosen, in the wheat and wool growing area some 200 miles west of Sydney, electrical distraction is at a minimum, wind velocities are below 10 m.p.h. for 88 per cent of the year and below 20 m.p.h. for 99·5 per cent of the year, and the level terrain of the western plains will make the site suitable for future interferometer measurements.

The designers of the telescope are Freeman, Fox and Partners of London, and a contract was let in July, 1959, to Maschinenfabrik Augsburg-Nurnberg, A.G. Sub-contractors are Concrete Constructions, N.S.W., for the foundations and tower ; Metropolitan-Vickers Electrical Company Ltd., for servo controls ; and Askania-Werke, West Berlin, for the master control unit and error detection system.

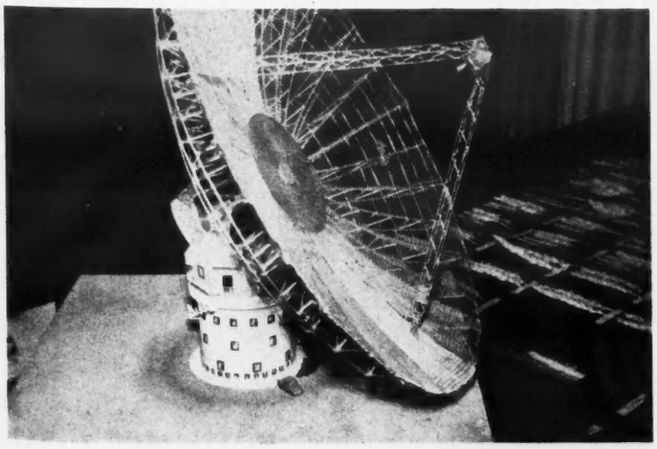
The structure is mounted on a reinforced concrete tower 40ft in diameter, and 40ft high. The telescope mount allows 360 deg. of rotation about a vertical axis and 60 deg. in elevation, and moves on four bogies on an azimuth track 2ft wide on the top of the tower. The azimuth track is cast in segments bolted together and the hub structure moves on an elevation rack 27ft and in radius.

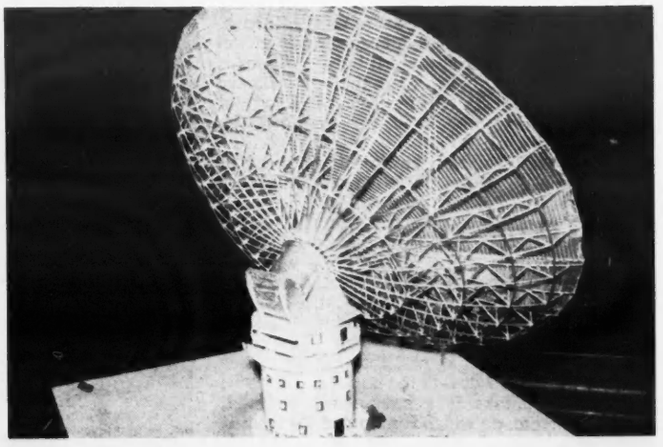
The structure is uncompensated, as the diameter is not great enough to be affected by gravity or wind loads, and the reflector is supported on thirty welded tube trusses, each 95ft long, set radially and located at their extremities by a ring. A geodetic interlayer on the trusses supports the mesh reflecting surface and adds rigidity to the truss assembly. The surface of the disc is parabolic within $\pm\frac{1}{2}$in.

Tracking control, within one minute of arc, is programmed to give the required motion to a small mirror located at the intersection of the rotating and elevating axes, and focussed on to an optical error detection system mounted on the rear centre of the main disc. The departure of the disc centre from the mirror axis is measured by the detection system, and compensations are fed into the motors driving the azimuth bogies elevating mechanism.

The concrete structure has been completed, and erection of the steelwork is to begin during July, 1960. The telescope is due for completion in early 1961.

The photographs reproduced are of a model of the radio telescope prepared by the Victorian Museum of Applied Science, and are printed by courtesy of the Museum.





210ft radio telescope model in Victorian Museum of Applied Science

CONTINENTAL AFFAIRS

by Our Continental Editor

Moselle Canal Progress

No. III—(*Concluded from page* 256, *August* 5)

The Moselle Treaty signed in October, 1956, *by France, the German Federal Republic, and Luxembourg, provides for making the river navigable for* 1500-*tonne vessels between Thionville and the confluence with the Rhine at Koblenz. It is hoped to have the canalisation in use by* 1963, *initially with a capacity of* 10,000,000 *tonnes per annum. Some* 800 *million kWh of electricity will also be generated in power stations making use of tubular Kaplan turbines* (" *bulb*" *turbines*). *The navigation is to be extended to Metz by widening the existing Iron Ore Canal to carry ships of* 1500 *tonnes. On its completion, the Moselle Canal is to be operated as an international waterway under a similar règime to the Rhine. The accompanying article describes the project and some of the work now being carried out.*

Power Stations

ALL the barrages except the two in the French section (Apach and Königsmacher) will be utilised to generate electric power. The hydro-electric exploitation of the German and German–Luxembourg sections is in the hands of a separate company, the Moselkraftwerke G.m.b.H., Trier. Because of the comparatively small available heads, ranging from 4m (at Palzem) to 9m (at Detzem), use will be made of tubular Kaplan turbines (" bulb " turbines).

Palzem and Grevenmacher are to have two sets, each with a flow capacity of 95 cumecs per turbine and generating 17,000,000 kWh per annum per turbine. The remaining ten stations, —Koblenz included—will have four sets each, with turbines of the same size with a normal rating of 380 cumecs per station and 420 cumecs maximum flow. Total annual output will be 780 million kWh, which includes the present output of 65,000,000 kWh from Koblenz power station which has been in existence since 1951. Total annual generation will thus be about 850 million kWh from an installed capacity of 180MW.

Compared with classical Kaplan turbines horizontal tubular turbines can be more closely spaced and require power stations of lower width while having approximately the same depth. The fact that the power stations on the Moselle require only two-thirds the length of the traditional station is of importance because in the narrow valley where space is at a premium this leaves more width for the barrage gates. The low construction height is also a favourable factor in preserving amenities by making the station less conspicuous.

Fig. 8 shows a section through the power-house at Trier, the four turbines for which are being supplied by Escher Wyss G.m.b.H., Ravensburg. The maker states that according to model tests the efficiency of straight tubular turbines is about 3 per cent higher than that of ordinary Kaplan turbines with curved discharge pipe, and that the discharge capacity is also greater for the same runner diameter.

Each of the turbines is laid out for a speed of 78 r.p.m. and a generator speed of 750 r.p.m., which is obtained by interposing a co-axial planetary gearbox between turbine and generator. At a head of 5·08m, the flow is 99·5 cumecs and the output 6000 h.p., while at 6·85m head, the power is substantially the same for a flow of only 72·2 cumecs. At a head of 3m, the turbine discharge is 98 cumecs and the output 3210 h.p.

As our illustration shows, the turbine axis is inclined by about 7 deg. to the horizontal. Within the concrete intake is a streamlined pedestal, also of concrete, on which is mounted the welded turbine casing. The interior of the casing is accessible at all times by way of an entrance shaft above. The casing is additionally supported by radial steel struts which are twisted so as to impart to the water a preliminary counter-rotation. These supports are followed by the adjustable guide vanes and the variable pitch turbine runner.

In the bottom space of the machine hall is the oil plant providing oil for control and bearing lubrication. Electrical oil pumps permit the bearings to be jacked before starting up the machine itself. Bearing oil pressure is maintained during running by a further oil pump driven by the turbine through a vertical take-off shaft.

Control of the set is carried out by a controller in the upper section of the machine hall, which incorporates an upper oil tank for bearing lubrication and for the servos. Safety is increased by having, in addition to an accumulator at the controller, weights fitted to the guide vane operating levers which automatically close them if the hydraulic controls should fail.

Stop beams can be inserted at inlet and outlet and the water spaces of the turbine, as well as the lower machine hall, can be pumped dry by means of electrical pumps. A 35-tonne travelling crane allows the machinery to be taken out for overhaul. The comparatively low height of this crane in turn makes possible a low building height of the station.

One of the turbines is shown in Fig. 9 at the maker's works. For ease of transport the fabricated casing is manufactured in a number of parts which at the site are bolted up and rendered watertight by running a weld along the joints. In order to resist the water pressure both the casing, of approximately 4m diameter, and the 3m wide entrance shaft are internally reinforced by rolled steel " T "-frames and stringers.

Access through the shaft is by way of a staircase. Warm air from the generator is exhausted through ducts. Both the generator, supplied by Brown Boveri et Cie, and the Stoeckicht planetary gear, made by Hüttenwerk Sonthofen, are accessible from all sides and can be dismantled and replaced through the entrance shaft. Between generator and gearbox, a flexible toothed coupling is inserted.

The turbine shaft is radially supported by a bearing inside the gearbox and another at the runner, while the axial thrust of 125 tonnes is taken up by a Michell bearing which is completely filled with oil. The thrust bearing is completely sealed on the runner side by a special gland which can be repacked while the turbine is standing still, using a temporary seal.

The servo-motor for the runner blades is situated in the runner hub. The piston is fixed to the hub while the cylinder moves to and fro to actuate the pitch control mechanism. Servo oil is admitted and discharged through the hollow turbine shaft by means of a rotary sleeve connection with the stationary part of the control system. The movement of the servo-cylinder is fed back to the controller by a mechanical linkage.

The adjustable guide blades are situated in a fabricated outer casing of conical shape which is grouted into the concrete ; the inner casing, supporting the stub shafts at the tops of the guide blades, is an iron casting. The guide blades are welded and provided with rubber sealing strips. They can be individually dismantled.

For the runner casing, a horizontally-split, fabricated design was adopted. Access to the

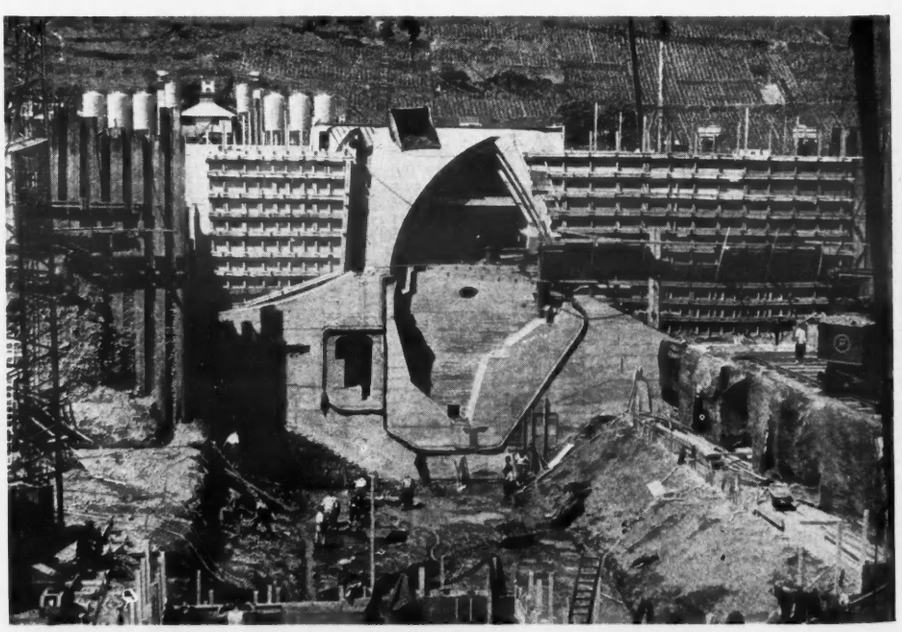
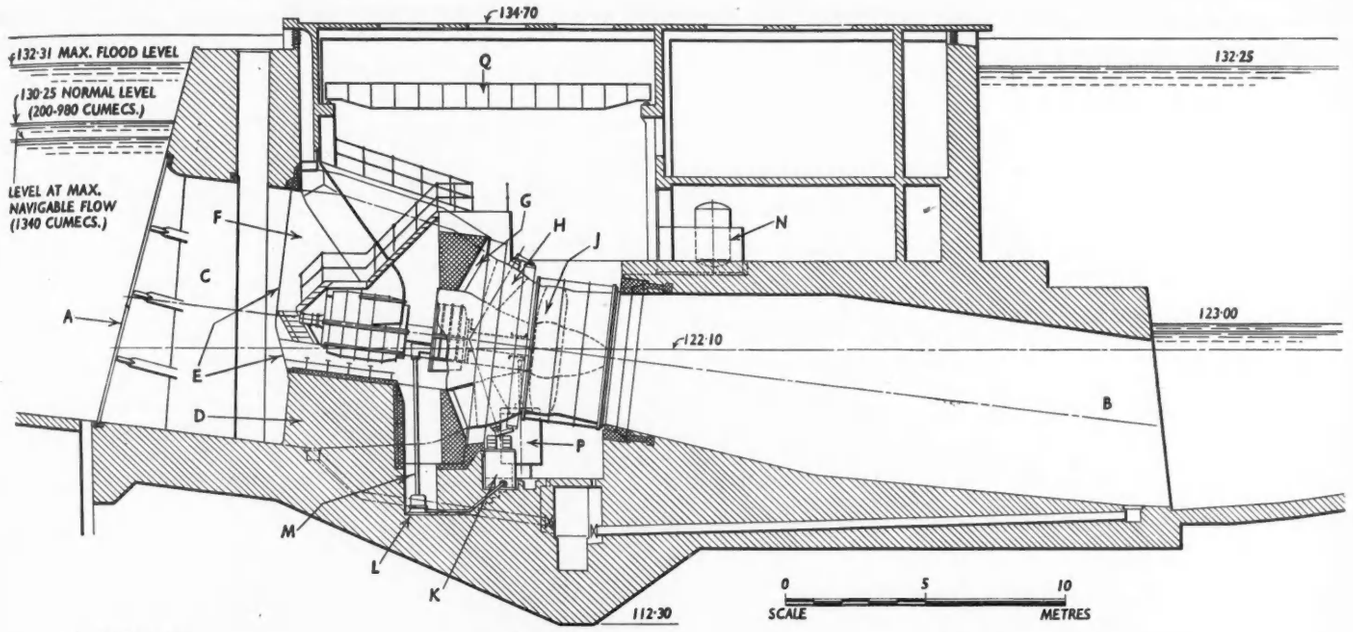


Fig. 7—Foundation and piers of barrage at Lehmen under construction during summer 1959



A—Intake screen.
B—Discharge.
C—Inlet chamber with stop beam frame.
D—Concrete machine base.
E—Turbine casing.
F—Access shaft.
G—Support blades.
H—Guide blades.
J—Runner.
K—Oil hydraulic unit for lubricating and servo oil.
L—Oil pump.
M—Pump driving shaft.
N—Controller and switchboard.
P—Weight for emergency closure of guide blades.
Q—Travelling crane.

Fig. 8—Section through power-house at Trier, showing a typical bulb turbine installation. Between Trier and Koblenz a total of thirty-six bulb turbines ("tubular turbines") will be installed in nine river stages

runner for maintenance can be gained through an inspection manhole at the top. It is easy to remove the cover of the casing, which then enables the Kaplan runner to be dismantled if necessary. It has been possible by sending out the turbine in the form of sub-assemblies to reduce the assembly time at the site from approximately eight months for a normal Kaplan turbine to about five months. It is expected to have the first set in operation at the beginning of October, with further sets following at the rate of one every two months. For the power station at Detzem, Escher Wyss is supplying a further four sets of almost identical design. These will be installed from April, 1961, onwards. Later they are also to be used as pumps, at an increased speed of operation.

Channel

Throughout the length of the Moselle navigation a channel with a depth of at least 2·9m must be provided, with a minimum width in the straights of 40m and more in the curves. This involves the excavation and removal of approximately 8,000,000 tons of alluvia and rock.

Progress

The original scheme of starting work at two sites in 1958, three in 1959, four in 1960, and two on the German–Luxembourg border in 1961 could not be adhered to after 1958, on account of planning delays and the tardiness of the German legal machinery.

This summer work on the barrages and/or locks is being carried out at Lehmen, St. Aldegund, Zeltingen, Detzem, Trier, Apach and Königsmacher. Of these, Lehmen and Trier are approaching completion. Cutting of the channel and other work on the reach is proceeding at Koblenz, Wintrich, and the French reaches, and this part of the work is being prepared at Lehmen, Fankel, St. Aldegund, Detzem and Trier.

Fig. 9—One of the three 6000 h.p. tubular turbines for the power station at Trier during assembly at the maker's works

Work at seven of the barrage sites remains to be started, therefore, and as about 2¾ years elapse between the beginning and end of construction of each stage the Moselle Company will be hard pushed to actually complete the work in 1963. It is, however, still hoped to have the canal open to traffic by that time although some weir openings will still be enclosed by stop beams.

Quantities

Exclusive of ancillary works, the total quantities involved in the canalisation amount to the following :

Earth movements :	
At the barrage sites	5,000,000 cubic metres
Dry work in the reaches, emergency bays	6,200,000 cubic metres
Dredging and rock excavation in channel :	
Alluvium	4,800,000 cubic metres
Rock	2,400,000 cubic metres
Concrete	850,000 cubic metres
Sheet piling incorporated, &c.	25,000 tonnes
Steel structures (weirs and lock gates)...	10,000 tonnes
Cement	250,000 tonnes
Aggregates	1,750,000 tonnes
Reinforcement steel	18,000 tonnes
Rock fills	500,000 tonnes

Main Contractors (April, 1960)

Koblenz.—Hulskens & Co., Wesel with Gebr. Meyer, Cologne (channel). Lehmen.—G. Noell & Co., Würzburg (tail gate), Maschinenfabrik Esslingen, Esslingen (crown gate), Fried. Krupp, Rheinhausen, with Rheinstahl Union Brückenbau A.G., Dortmund (sector gates), Ph. Holzmann A.G., Bad-Ems (civil engineering). Müden–St. Aldegund.—Société des Forges et Ateliers du Creusot, Paris (sector gates). St. Aldegund.—Group comprising Ed. Züblin A.G., Frankfurt (Main) ; Held & Francke Bau-A.G., Munich ; Ph. Holzmann, Frankfurt (Main) ; Thormann & Stiefel A.G., Munich ; and Sager & Woerner, Munich (civil engineering). Enkirch.—Group comprising Leonhard Moll G.m.b.H., Munich ; Hochtief A.G., Koblenz ; Kunz & Co., Munich ; Oltsch & Co., Zweibrücken ; Dumez, Paris ; and Société de Construction des Batignolles, Paris (civil engineering). Group comprising B. Seibert, Saarbrücken and Neyrpic, Grenoble (sector gates) ; G. Noell & Co., Würzburg (tail gate), Maschinenfabrik Esslingen, Esslingen (crown gate). Zeltingen.—Group comprising Wiemer & Trachte, Dortmund ; Franz Bruggemann Baugesellschaft, Duisburg ; and F. C. Trapp, Wesel (civil engineering) ; G. Noell & Co., Würzburg (sector gates). Wintrich-Detzem.—Group comprising Dr.-Ing. Joachim Rathjens, Hamburg-Altona, Müller Frères, Boulay (Moselle) ; Heinrich Kniffler, Saarbrücken (channel). Detzem.—Group comprising Beton-und Monierbau A.G., Düsseldorf ; Dyckerhoff & Widmann, Wiesbaden ; Siemens Bau-Union, Frankfurt (Main) ; Société Belge des Bétons, Brussels ; Cie Industrielle de Travaux, Paris ; Société Nord-France, Paris ; and Entreprise Fougerolle, Paris (civil engineering) ; Louis Eilers, Hannover-Herrenhausen ; M.A.N., Gustavsburg (sector gates) ; G. Noell & Co., Würzburg (tail gate) ; Maschinenfabrik Esslingen, Esslingen (crown gate). Trier.—Heilmann & Littmann, Munich, (civil engineering) ; Group comprising Dinglerwerke A.G., Zweibrücken, and G. Noell & Co., Würzburg (sector gates) ; G. Noell & Co., Würzburg (tail gates) ; M.A.N., Gustavsburg (crown gate). Apach.—Group comprising Entreprise Léon Ballot, Paris ; Ruvenhorst & Humbert, Avignon (civil engineering) ; Société des Ateliers et Chantiers de France, Dunkirk (lock gates). Apach-Thionville.—Group comprising Dumez, Paris ; Société des Travaux Publics et Privés d'Alsace et de Lorraine, Strasbourg ; Oltsch & Co., Zweibrücken ; Leonhard Moll G.m.b.H., Munich (channel). Königsmacher.—Group comprising Union des Travaux et de Entreprises, Paris ; Seibert, Saarbrücken (civil engineering—barrage) ; Group comprising Les Travaux Souterrains, Paris ; Cie Dunkerquoise d'Entreprises, Paris ; Bernhard Fischer K.G., Duisburg ; Charles Brandt, Saarbrücken (civil engineering—lock) ; Group comprising Union des Travaux et d'Entreprises, Paris ; Seibert, Saarbrücken (sector gates).

CONTINENTAL AFFAIRS *(Continued)*

Silicon Rectifiers in Main Line Service

After experiments with silicon rectifiers in a motor coach, the French National Railways decided to equip a main-line locomotive in this way. The locomotive, described in the following article, is based at Strasbourg and shares heavy main-line duties with other classes having conventional mercury-arc traction rectifiers.

GERMANIUM was the first semiconductor material to operate in commercial service as a traction rectifier, but its use was generally regarded as a temporary phase of development pending the introduction of silicon for the same purpose. In France there was a short period of experiment with germanium in 1956–57, using the motor coach which had already served for testing ignitron rectifiers. This vehicle was equipped with ignitrons in 1951, and had been operating on the line from Aix-le-Bains to La Roche-sur-Foron since that date. In November, 1958, it was fitted experimentally with silicon rectifiers by Le Matériel Electrique Schneider-Westinghouse, which had begun production of silicon cells at its Champagne-sur-Seine plant in the spring of that year.

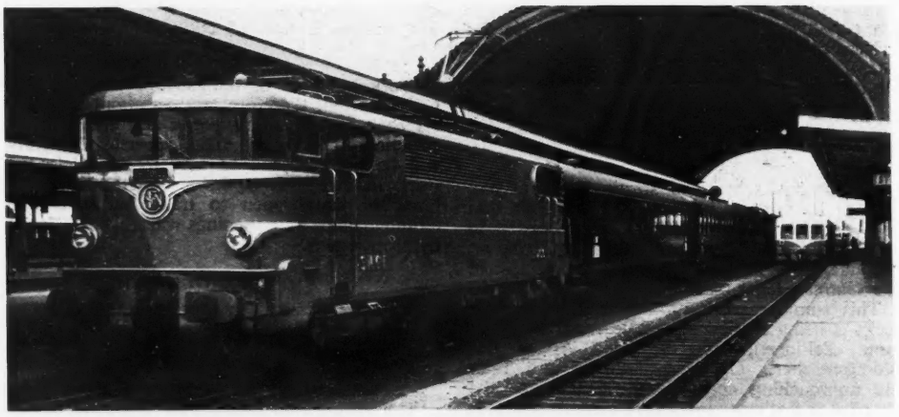


Fig. 1—French National Railways locomotive No. 20103, with silicon rectifiers, on Dunkerque-Basle train at Strasbourg

After successful experiments with the motor coach, the same company was asked by the French National Railways to equip a powerful 25kV, 50 c/s main-line locomotive with similar rectifiers. The locomotive selected for the purpose was No. 20103 (Fig. 1), one of the four dual-frequency B_0-B_0 prototypes stationed at the Strasbourg depot for working mainly between Luxembourg and Basle, where they are able to run over the Swiss 15kV, 16⅔ c/s system if required. In practice such inter-running is confined at present to short distances in the Basle station area. No. 20103 had been equipped originally with single-anode excitron rectifiers and was the first of the S.N.C.F. designs to have one traction motor in each bogie geared to both axles, a principle since adopted on a large scale in the "16500" class a.c. and "9400" class d.c. locomotives (see our issue of May 6, 1960).

Characteristics of the locomotive are shown in Table I. The present weight of 81·5 tons is 3·5 tons less than the original weight when the locomotive was equipped with excitron rectifiers.

TABLE I

	25kV 50 c/s	15kV 16⅔ c/s
Continuous rating	4880 h.p.	3920 h.p.
Corresponding tractive effort	29,350 lb	29,350 lb
Speed	60 m.p.h.	48 m.p.h.
One-hour rating	5250 h.p.	4150 h.p.

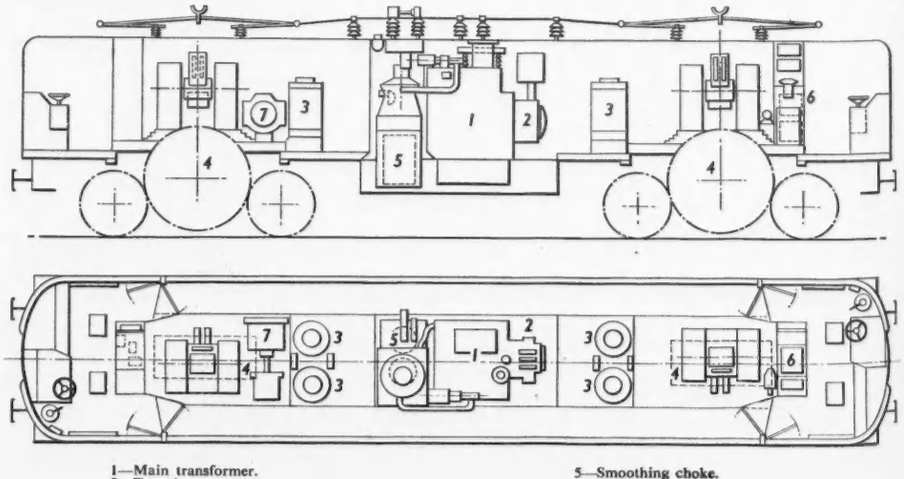
The layout of the principal equipment in the locomotive after its conversion to silicon rectifiers is seen in Fig. 2. The motor-blowers, resistance groups for field-weakening and a permanent resistive shunt for smoothing purposes are supported from the roof at each end of the body above their respective motors, to which the air is fed through rubber connections. Fig. 2 clearly shows the free space for movement in the equipment compartment as a result of the small diameter (2ft 3½in) of the four silicon assemblies. This characteristic was particularly evident when, by courtesy of the French National Railways, we were able recently to inspect the locomotive at Strasbourg depot and to compare it with the "sister" machine, No. 20104, which still has its excitron rectifier cubicles in the corresponding areas of the locomotive body.

Each silicon rectifier assembly forms one arm of a bridge circuit across which the two motors are connected in series. A connection from the mid-point of the motor circuit to a centre tap on the traction transformer secondary gives the arrangement similar characteristics to a parallel motor circuit by equalising the voltage across the motors if wheelspin in one bogie tends to increase the voltage drop across the machine affected, and compensates similarly for the effect on the motors of differences in wheel diameter between the two bogies.

Control is effected at high voltage on a tapped auto-transformer winding which provides thirty-two running notches and two weak-field steps by means of field diversion, the latter being available from notch 24 onwards. The tap-changer is of the C.E.M. rotary pattern described in our June 17, 1960, issue in connection with the French-built locomotives of the U.S.S.R. Railways. It is operated by a handwheel on the driver's desk, which is turned continuously clockwise for notching up through any number of steps, the tap-changer itself following at a slower rate and stopping when it has reached the notch selected on the handwheel. An indicator on the desk shows the notch at which the tap-changer is set at any moment and the notch selected by the driver, the two normally corresponding. The full range of notches is available on both supply voltages. The tap-changer operates in oil, which is circulated by a motor-driven pump for filtering purposes.

As a result of the different frequencies of the French 25kV (50 c/s) and Swiss 15kV (16⅔ c/s) traction systems, no change is made in the traction circuits when passing from one to the other, the reduced inductive volts drop on 16⅔ c/s compensating for the lower supply voltage associated with this frequency. The bridge arrangement of the rectifiers has allowed economy in the size of transformer necessary to give the required characteristics on both frequencies. A much larger core would have been necessary for dual-frequency working if a simple full-wave arrangement had been used with the motor current flowing through one half of the secondary winding on each half cycle. At the same time, as indicated above, the same adhesive qualities are obtained as in the numerous S.N.C.F. locomotives having parallel motors, each fed by its own pair of rectifiers connected for full-wave rectification.

All but one of the auxiliary machines are driven by d.c. motors fed by selenium rectifiers, and for these circuits it is necessary to adjust the input to the rectifiers according to whether the line supply is 25kV or 15kV in order to maintain a similar output to the machines. The adjustment is made automatically by means of feeler relays and contactors with electrical interlocking. The one a.c. auxiliary is a series commutator

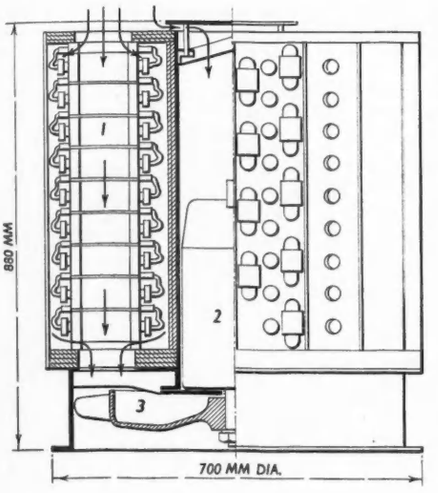


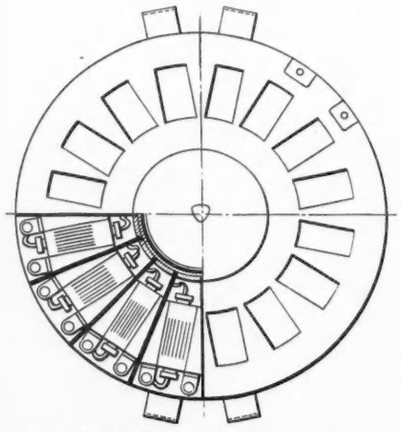
1—Main transformer.
2—Tap changer.
3—Silicon rectifier assembly.
4—Traction motor.
5—Smoothing choke.
6—Cab locker.
7—Compressor.

Fig. 2—Arrangement of equipment in locomotive

motor driving the compressor, which operates without change of connections.

Details of a rectifier assembly are seen in Fig. 3. The cylindrical assembly contains fourteen vertically mounted trays in each of which are contained eight rectifier units. A unit comprises two silicon cells mounted at opposite ends of a finned block, the blocks being placed one on top of the other in the trays





1—Vertical stack of silicon rectifiers (two per unit).
2—Fan motor.
3—Fan.

Fig. 3—Rectifier assembly forming one arm of bridge circuit

so that air drawn through the top of the assembly by a built-in fan flows through each stack of blocks and is discharged under the locomotive. Each cylinder forms one arm of the bridge rectifier and contains 224 cells connected as fourteen parallel circuits of sixteen cells in series, making a total of 896 cells in the bridge. The rectifier trays can be lifted out vertically after removal of the end connections. Protective resistances, balancing the inverse voltages between pairs of cells in series, and resistance-capacitor groups for smoothing voltage surges due to commutation are connected between units.

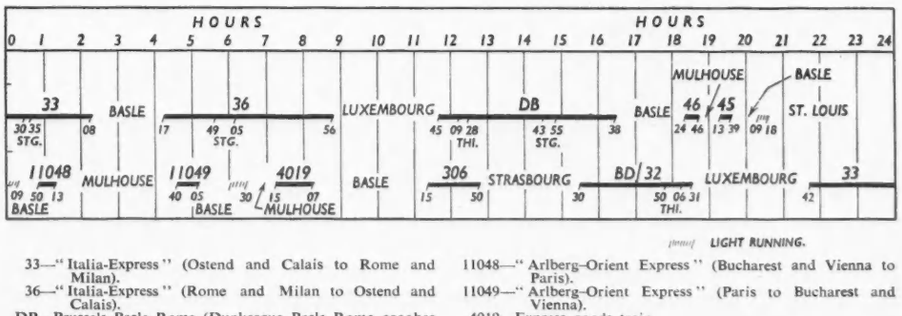
With a 25kV supply and the tap-changer on its highest notch, the no-load voltage applied to the rectifier from the traction transformer secondary is 2887V. The continuous current rating is 2270A. At starting the total current may reach 4000A, but the average per cell in these conditions is 200A and the rating 9kW. Rated peak inverse voltage per cell is 258V, but the maximum is 1200V, giving a safety factor of about 4·5. The complete silicon rectifier installation with its self-contained ventilating fans weighs 3530 lb.

In case of faults, various combinations of motors and rectifiers can be selected by means of switches in the driving cabs and link connections in the equipment compartment. Either motor may be isolated and the remaining machine supplied at its normal voltage by two arms of the bridge acting as a full-wave rectifier. Similarly, two arms of the bridge can be connected to feed two motors at half-voltage. Protection by the normal relay-operated circuit breaker in the locomotive would not be rapid enough to prevent damage to the rectifiers in the event of faults in the d.c. circuit or within the bridge itself. An additional device has therefore been installed which on the occurrence of such faults short-circuits the traction transformer secondary within two milliseconds, thus diverting current from the bridge and imposing an overload on the transformer which causes operation of the normal overload relay and trips the main circuit-breaker. The short-circuiting contact, mounted on a vertical rod, is normally held up and clear of the fixed contact, against spring pressure, by a permanent magnet. On detection of a fault, electronic apparatus sends a current pulse through a winding arranged to cancel the permanent magnet flux and cause the moving contact to be closed on to the fixed contact by the action of the spring.

Modifications to the control circuits and cabling of the locomotive were made necessary by the installation of silicon rectifiers, and a single centre-tapped smoothing choke was substituted for the two units originally fitted. This is cooled by a vertically-mounted fan which also serves the transformer oil radiator. These modifications were carried out at the Strasbourg depot of the S.N.C.F. Strasbourg has shedded the four dual-frequency prototypes since their introduction, being responsible for the motive power of international passenger trains running between Luxembourg, Lille and Basle via Thionville. Since electric traction was introduced from Luxembourg to Basle, the journey time has been cut by one hour. We were supplied with the accompanying diagram (Fig. 4) of the two-day duty cycle worked by No. 20103 by Monsieur Zagula, Chef de Dépot Principal at Strasbourg, to whom also we are indebted for the information which follows concerning operations at this major centre of electric motive power. It will be seen from Fig. 4 that in addition to its longer runs between Luxembourg and Basle, No. 20103 fills in its time while at Basle with a number of short trips between there and Mulhouse on trains to and from Paris, for which Mulhouse is still a changeoverpoint between steam and electric traction. During the two-day duty cycle shown in Fig. 4, No. 20103 covers 1650 km, of which 48 km are light running accounted for by a return trip between Basle station and St. Louis depot, and the run from Basle to Mulhouse to pick up an express goods train.

There are now 110 electric locomotives attached to Strasbourg depot. The most numerous are the " 13000 " class B_0-B_0 with a.c. series motors, of which there are forty-eight. This is one of the original designs for the Valenciennes–Thionville electrification, and is still much in evidence throughout the Lille–Basle line in spite of the later concentration on rectifier designs. On the occasion of our visit one of these locomotives hauled the Dunkerque–Basle train, by which we travelled, from Lille to Thionville, where No. 20103, coming down from Luxembourg with the Brussels portion, took over the combined train. There are also thirty-two of the " 16500 " class mixed traffic B_0-B_0 with variable gear ratio, used at Strasbourg largely for goods traffic so that the alternative passenger ratio is not often engaged ; and twenty-six of the " 16000 " class B_0-B_0 for the principal passenger duties, including through working between Basle and Lille of the Basle–Calais trains, which at holiday seasons may load to some twenty vehicles and 1200 tons. The four dual-frequency locomotives make up the total of 110 and are similarly employed on long-distance passenger trains. With this fleet of locomotives Strasbourg works some 33,532 km daily, including all traffic on the Paris main line to and from Blainville. The monthly total—1,200,000 km in round figures—compares with 280,000 km to 300,000 km operated when Strasbourg was a steam depot with 100 locomotives. In May this year only three failures requiring replacement of a locomotive occurred in the 1,200,000 km worked by the depot.

Maintenance time on the electric locomotives is about a fifth of that required with steam. Locomotives are scheduled to have a half-day in the depot for inspection and servicing as necessary every two months and a whole day every four months. The silicon rectifier locomotive follows the normal regime of the depot, and we were informed during our visit that by June 1 this year it had run 109,000 km on the important main-line duties already described.



33—" Italia-Express " (Ostend and Calais to Rome and Milan).
36—" Italia-Express " (Rome and Milan to Ostend and Calais).
DB—Brussels–Basle–Rome (Dunkerque–Basle–Rome coaches attached at Thionville).
46—Basle–Paris.
45—Paris–Basle.
11048—" Arlberg–Orient Express " (Bucharest and Vienna to Paris).
11049—" Arlberg–Orient Express " (Paris to Bucharest and Vienna).
4019—Express goods train.
306—Basle–Amsterdam.
BD 32—Rome–Brussels (Basle and Rome to Dunkerque coaches detached at Thionville).

Fig. 4—Two-day duty cycle of rectifier locomotive

Water Pollution Control in Europe

At the fourteenth session of the Economic Commission for Europe (E.C.E.), held in the spring of 1959, a resolution was adopted under which, in collaboration with the World Health Organisation and the Food and Agriculture Organisation, a seminar of experts is to be organised in February, 1961, to discuss the economic, administrative and technical as well as the health aspects of water pollution. The resolution also requested the E.C.E. Secretariat to prepare a list of the most urgent problems in Europe which could usefully be considered by the Government experts. A meeting to prepare the seminar scheduled for 1961 was held from May 30 to June 3 at the W.H.O. regional offices in Copenhagen. This meeting was organised jointly by E.C.E., F.A.O. and W.H.O. in close collaboration with the International Atomic Energy Agency, and was attended by representatives of the secretariats of these organisations and by qualified experts from various countries, who had been invited as consultants. Items which it was decided to include in the seminar's agenda are : the present state of regulations and procedures for water pollution control and existing practices, economic aspects, and international action to be undertaken for this purpose.

Utkal Machinery Private, Ltd.

In our issue for July 22, page 162, we erroneously stated the foundation capital of Utkal Machinery Private, Ltd., Bombay, as 50,000,000 rupees, whereas the correct figure is 12,500,000 rupees.

THE AMERICAN SCENE

by Our American Editor

Compact Apparatus for Generating High Pressures

A very compact high-pressure apparatus has been designed and built by the National Bureau of Standards to make possible determinations of the properties of materials at high pressures, with the objectives of establishing "fixed points" on the pressure scale, and of devising improved pressure measurement techniques. The instrument can be operated by a conventional hydraulic press. The press forces an anvil downward on one face of a small tetrahedron of pressure-transmitting material. Three other anvils transmit wedge reaction forces from a steel retaining ring to the other faces of the tetrahedron, which functions as a pressure cell. While under pressure in this cell, a specimen may be subjected to resistance heating, or its temperature, electrical resistance, or other quantities can be measured.

AN extremely compact multi-anvil wedge apparatus for generating high pressures has been designed by E. C. Lloyd, U. O. Hutton, and D. P. Johnson, of the National Bureau of Standards, Washington, D.C. The apparatus produces pressures of 100,000 atmospheres and above by the application of force against each face of a ½in regular tetrahedron of pyrophyllite (hydrous aluminium silicate). The device was made to help in the study of the properties of materials at high pressure so that "fixed points" can be established on the pressure scale, and so that improved pressure measurement techniques can be developed. Other devices for a similar purpose have been made by H. Tracy Hall with four independent hydraulic rams to apply forces to the faces of a tetrahedron. The present design, however, consists of an assembly in which external force is applied to only one of four anvils, with wedge reaction forces acting on the remaining three anvils. Because only one external force is needed to operate it the apparatus can be used in a conventional hydraulic press. The apparatus has a diameter of only 8in at its lower bolster. While a specimen is under high pressure, four electrical connections through the anvils permit resistance heating of the specimen and measurement of its temperature, electrical resistance or other quantities.

Fig. 1—Wedge-type high-pressure apparatus with 1in tetrahedrons being positioned in hydraulic press

Although apparatus of the kind described here lends itself, in special applications, for use with solids having a larger number of faces, the regular tetrahedron appears to be the most generally desirable shape, and is the only one used with the apparatus so far. This configuration has the attractive possibility of permitting the use of existing presses of very large capacity to obtain high pressures in volumes of several cubic inches. The availability of high pressure in volumes of this size would present the possibility of practical two-stage devices to obtain still higher pressures.

Construction and Operation

The initial apparatus, which is illustrated in the accompanying photographs, uses anvils having triangular faces ½in on an edge to accommodate tetrahedrons of pressure-transmitting material of $\frac{9}{16}$in edge-length. The half angle of the inner surface of the conical ring is 18½ deg. In operation, the clamping force of a hydraulic press applied to the upper anvil and the bottom of the containing ring causes the three lower anvils to slide downward along the inner conical surface of the containing ring, and the resulting wedging forces result in substantially equal motion of all four anvils toward the centre of the pyrophyllite tetrahedron.

Measurements made during initial tests of the equipment at 100 tons load, corresponding to a calculated pressure of nearly 125,000 atmospheres, showed deformation of the conical ring into a three-lobed shape that fitted inside a circle about 0·001in larger in diameter than the unloaded ring. Based on this deformation, stresses in the ring appear to be consistent with design stresses. No evidence of permanent deformation of the ring or anvils has been found after more than 10 cycles to a ram load of 100 tons.

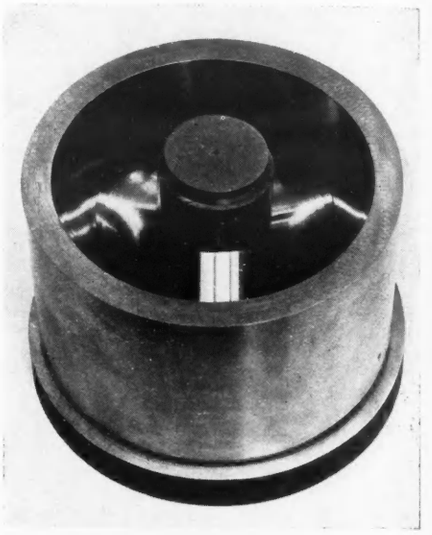


Fig. 2—High-pressure apparatus with one upper anvil, three lower anvils and conical ring

The machining of the butt-faces of the three lower anvil assemblies, to conform to the shape of the ring in the final position of the anvils, was done with the use of the guide block shown. This block was originally also used during application of load to guide the anvils. This was found to be unnecessary, however, because of the self-locating effect of the faces of the wedges and their low frictional reaction in the cone, and the use of the guide block for this purpose was discontinued in order to simplify the electrical insulation of the anvils.

The material used for the anvil assemblies and the conical ring was SAE 4340 steel heat-treated to Rockwell 40/41 C, except for the anvils, which were of Allegheny Ludlum grade CA-4 tungsten carbide. The upper and lower bolster plates and the guide block were cold rolled steel. The pressure-transmitting material used has been pyrophyllite (hydrous aluminium silicate, $4SiO_2.3Al_2O_3.H_2O$) and, as in Hall's equipment, this pressure medium extrudes between rouged surfaces of the anvils to form a compressible

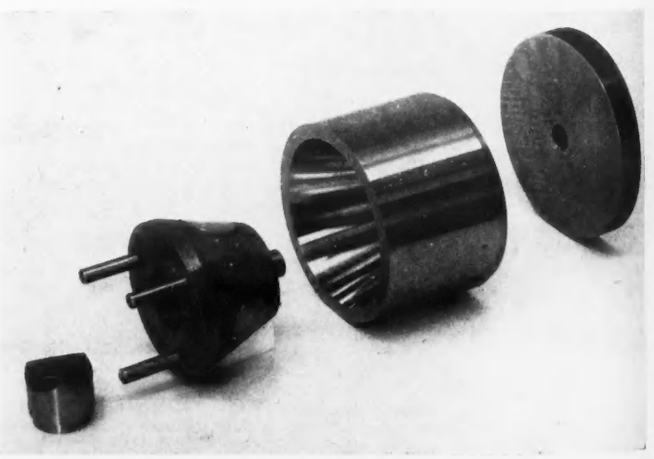


Fig. 3—Disassembled view of the apparatus, with the lower anvils installed in a conically-shaped guide block used for machining the butt faces

gasket. The specimen to be studied is contained in a cavity inside the tetrahedron, frequently a hole drilled between centres of opposite edges. The specimen size has been varied from 5 to 50 per cent of the tetrahedral volume, but if the specimen has been more than 10 per cent of this volume difficulty in preventing extrusion of the specimen through the gasket has frequently been encountered. This difficulty is decreased by more precise fitting of the tetrahedron.

With pyrophyllite tetrahedrons of $\frac{9}{16}$in initial edge-length, measurements made in initial trials of the equipment showed the total vertical motion of the upper anvil to be about 0·030in as the load was increased from 5 tons to 100 tons. The stroke for the initial 5-ton load varied depending on the amount of " slack " in the system. The time required to reach a load of 100 ton could be selected over a wide range, and any intermediate load could be held for periods up to several hours without difficulty. Using $\frac{9}{16}$in tetrahedrons the extrusion of pyrophyllite forms a gasket between the parallel anvil surfaces having a width of about $\frac{3}{32}$in and a thickness of about 0·006in, as shown in Fig. 4. In order to obtain an equal gasket thickness in all gasket areas the three lower anvils are initially spaced with plastic buttons, near the tetrahedral die area, of thickness to provide symmetrical positioning of the four anvils around the over-sized tetrahedron inserted in the cavity. Spacers of indium, block tin, or " Teflon " (when a non-conductor is desired), have been used with equal success, and the gasket is ordinarily extruded in quite a symmetrical configuration on all edges.

One of the difficulties to be expected in designing this equipment lies, of course, in overcoming the effects of excessive friction between the sliding anvils and the conical ring. A number of materials have a low coefficient of friction under heavy loading and appeared to be suitable for use as lubricants between these surfaces. Sheet " Teflon " 0·003in thick was first tried, and found to be so satisfactory that no other material has been used. In addition to serving as a lubricant the " Teflon " provides electrical insulation between the anvils and the ring. Tests on 0·003in sheet " Teflon," using the method of measuring the torque required to turn a smooth right circular cylinder loaded longitudinally, gave the values of friction tabulated here.

Average pressure, lb per sq. in	Starting friction	Sliding friction
33,000	0·011	0·007
66,000	0·012	0·008
83,000	0·014	0·010

These values of coefficient of friction correspond to a sliding angle of about $\frac{1}{2}$ deg. to 1 deg. ; accordingly, the half angle of the conical surface of the ring was made 18·5 deg., or 1 deg. smaller than the angle complementary to the angle between faces of the tetrahedron (70·528 deg.). This results in the forces exerted on the lower three anvils being within $\frac{1}{2}$ deg. of the axes of the anvils. The adequacy of the " Teflon " lubricant has been well demonstrated in more than thirty force applications, of which about ten were in the neighbourhood of 100 tons, without any evidence of metal-to-metal contact. In one test the same " Teflon " pieces were used in three successive force applications at 100 tons without failure.

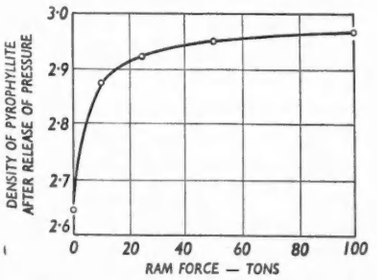


Fig. 6—Permanent increase in the density of pyrophyllite due to the application of pressure

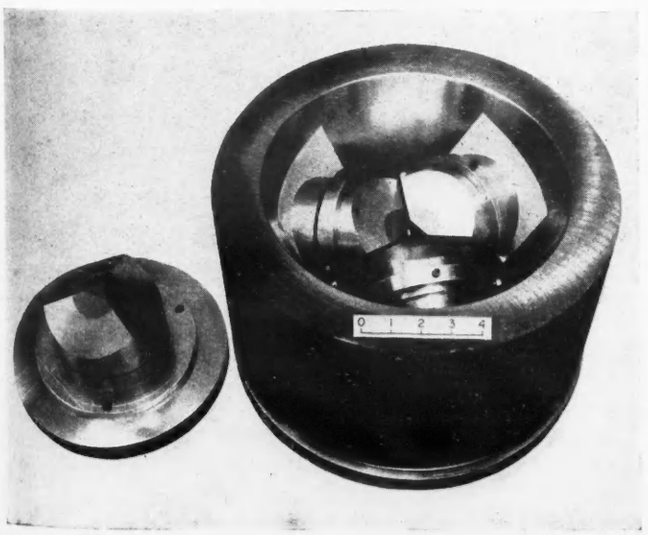
Measurements of the dimensions and density of the pyrophyllite tetrahedrons after being subjected to various pressures showed that this material increases nearly irreversibly in density with pressure, according to the curve of Fig. 6. The material exhibited relatively small elasticity in compression, so that only small increases in volume occurred after release of pressure.

The specimens to be subject to pressure are inserted in a hole up to $\frac{1}{8}$in diameter drilled from edge to edge of the tetrahedron, as may be seen in Fig. 5. In order to study the extent to which the pressure over such a specimen departs from true hydrostatic pressure, cylinders of indium were used, and the resulting deformations noted. Such a specimen is shown in Fig. 5. In specimens which were not extruded through the gasket there is a characteristic flattening of the ends parallel to the adjacent edges of the tetrahedron. The shear yield strength of indium under high pressures, comparable to those encountered here, is reported by Bridgman to be about the same as at ambient pressure, about 1000 lb per square inch. This suggests that the departure from uniform pressure over the surface of the indium specimen is only of the order of a few hundred atmospheres at most. A specimen material which is embedded, or sheathed, in an indium cylinder would thus be subjected to uniform pressure within pressure variations of this magnitude. Tests with still softer materials are planned to determine whether they can be contained by the pyrophyllite, and thus obtain a still better approximation to true hydrostatic pressure.

Figs. 7 and 8 are examples of pressure-resistance relationships obtained on specimens of bismuth and antimony, respectively. In each case the volume of the specimen was approximately 4 per cent of the volume of the tetrahedron. In the measurements of resistance of these specimens under pressure a four-lead circuit was used, in which two of the anvils served as current leads and the other two as potential leads. Connection to the specimen was by the use of silver foil strips as described by Halland, as illustrated by one of the tetrahedrons of Fig. 5. In investigations requiring heating of the specimen this arrangement of electrical connections is available, of course, for conducting heating current and for temperature measurements, and additional electrical connections would be available in a configuration using other shapes having a larger number of faces and anvils.

In Fig. 7 pressure is shown in terms of ram force for increasing and decreasing pressure. Superimposed is the pressure-resistance curve by Bridgman in which the pressure scale (abscissa) is linear ; the first transition points on increasing pressure have been made to coincide. The abrupt fall in resistance of bismuth reported by Bridgman to occur at 25,000 atmospheres is evident. Bridgman's second transition at 27,000 atmospheres (increasing resistance) is not sharply defined as to point of onset, but the maximum in resistance is definite. The displacement of the ascending and descending force versus resistance curves gives an indication of the hysteresis of this particular configuration of pyrophyllite and bismuth. The appreciable slope of this curve and the relatively wide force range over which the resistance transitions occur is probably due principally to two factors : the departure from uniform pressure over the surface of the bismuth due to internal friction in the pyrophlylite, and a departure from proportionality between ram load and specimen pressure during the constant-pressure reductions in volume of bismuth at its two transition points, which amounts to 4½ per cent and 3 per cent for the first and second points, respectively. This departure from proportionality evidently results from the additional gasket compression required to effect the reduction in bismuth volume at constant pressure. On decreasing pressure it will be noted that both transitions are displaced to ram forces corresponding to pressures considerably lower than Bridgman's values. This hysteresis is attributable partly to pressure " held " by the hysteresis effect of the pyrophyllite, which appears to increase significantly with the irreversible increase in density on application of pressure, and partly to friction between the anvils and the gasket.

Fig. 8 shows results for antimony, in which the relative resistance changes continuously up to the highest pressure reached, probably over



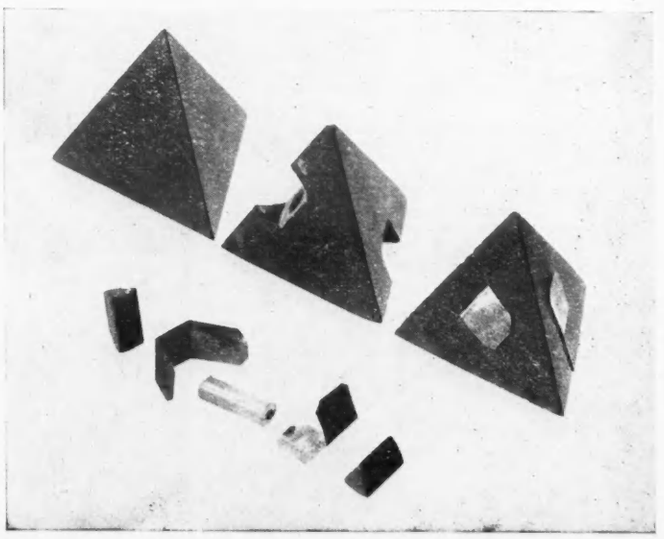


Fig. 4 (Left)—Wedge apparatus with upper anvil removed and with " Teflon " sheets in place between the bases of the lower anvils and the conical ring.
Fig. 5 (Right)—Pyrophyllite tetrahedrons and the pressure cell assembly, with notches and hole cut to receive the specimen and silver foils for electrical contacts

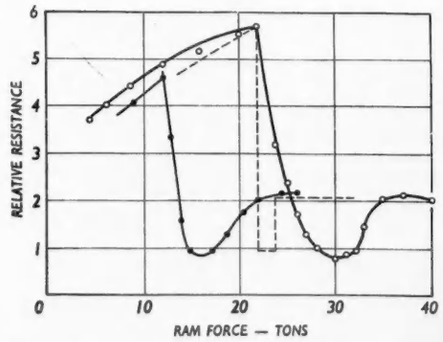
THE AMERICAN SCENE *(Continued)*

100,000 atmospheres. Although a volume discontinuity is reported by Bridgman at 85,000 atmospheres, he found no corresponding specific resistance change at this pressure. The antimony used in the present case was probably of substantially higher purity than Bridgman's sample.

The estimates of the pressures obtained have initially been by measurement of the ram force and the areas of pyrophyllite under pressure. Two principal uncertainties are involved in this method : the reduction in effective ram force due to the force supported by the extruded gasket, and the effect of internal friction in the pyrophyllite. Measurements made on the gaskets formed by single applications of force from 25 tons to 100 tons to $\frac{3}{16}$in tetrahedrons gave a gasket lateral area, nearly independent of the force, of approximately 50 per cent of the total area subjected to ram force. If the pressure in the gasket falls linearly from the edge of the tetrahedron to the free edge of the gasket, the net force acting on each face of the tetrahedron is approximately 75 per cent of the total ram force. However, the loss in pressure, on increasing force, due both to gasket forces and to internal friction of pyrophyllite appears to be only about 10 per cent, as indicated by values of ram force required to reach the first resistance transitions of bismuth and barium.

Future Work

The high-pressure equipment described will be used, as well as stepped-piston equipment, to study the properties of materials at high pressures, with the objective of establishing "fixed points" on the pressure scale, and of devising improved pressure measurement techniques. Further investigations of pressure-transmitting media appear desirable to provide improved performance of the equipment in various pressure ranges.

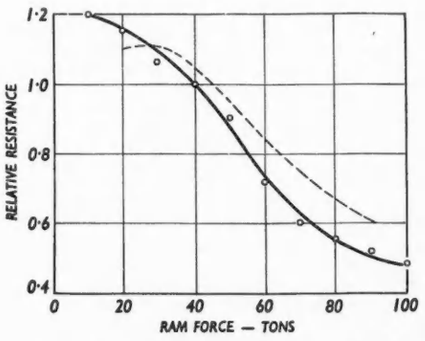


O Increasing force ; ● decreasing force. Bridgman's results, plotted to a linear pressure scale, are shown by the dashed line for comparison.

Fig. 7—Ram force versus resistance of specimen of bismuth, 99·99 per cent pure

The use of a larger tetrahedron would improve the ratio of tetrahedron volume to specimen volume, should reduce the proportion of force taken by the gasket, and would evidently provide more uniform pressure in the central volume. New apparatus is under design to apply 600 tons to tetrahedrons of about 1in edge-length, to investigate the advantages of larger size. The ultimate pressure attainable with the present equipment will be determined with the use of larger presses that will be available for further work. The absence of failure of any sort with repeated ram loads of 100 tons, the relatively low stresses in the conical ring, and the good performance of the "Teflon" lubricant, give an indication that substantially higher ram loads may be used.

The adaptability of the equipment to conventional hydraulic presses makes feasible consideration of the use of very large ram forces, with a corresponding increase in size of the tetrahedron to perhaps 2½in or 3in. The availability of high-pressure volumes of this size may make a two-stage device practicable. Such a device is proposed, utilising a large tetrahedron, in each face of which is embedded a second stage one-piece carbide anvil of such dimensions as to enclose a small tetrahedron at the centre. The four second stage anvils would probably be tapered with the small ends faced to accommodate a tetrahedron and its gasket, as in the present equipment, and with the large ends in contact with the faces of the primary anvils.



Bridgman's results, plotted to a linear pressure scale, are shown by the dashed line, for comparison.

Fig. 8—Ram force versus resistance of antimony, 99·99 per cent pure, on increasing force

The secondary anvils would be subjected to the pressure of the large tetrahedron over their lateral surfaces to provide the necessary supporting forces. An alternative to the use of two sets of anvils is the machining of each anvil pair as one piece. It seems likely that an adjustment of the parameters available, including relative dimensions of the large and small anvils, the elastic properties of the anvils and of the pressure transmitting media, and the relative volumes of large and small tetrahedrons, would provide a good chance of success of a two-stage device. Important in the proposed two-stage device is the availability of four electrical connections into the highest pressure volume via the four anvil pairs.

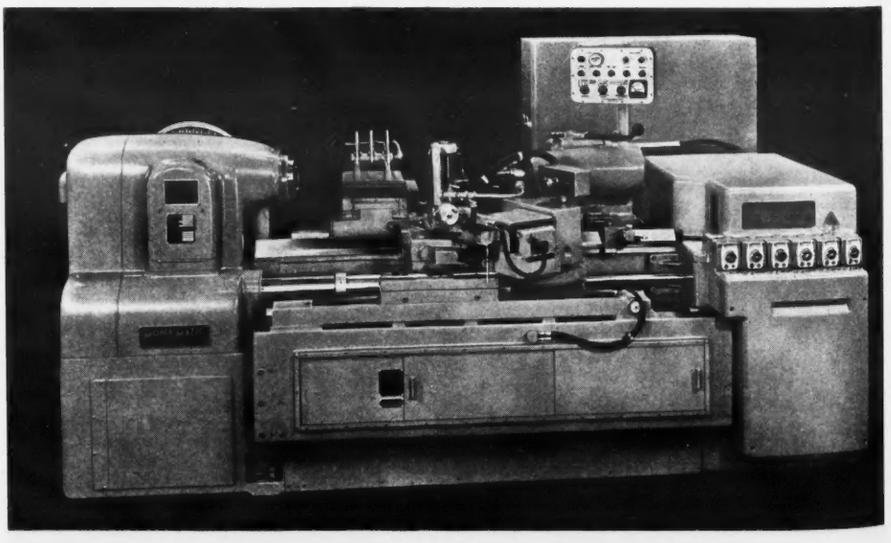
Production Lathe with Multi-Cut Cycling

A new production lathe, known as the Model 21-H "Mona-Matic," which is particularly adapted to the machining of workpieces requiring heavy stock removal, has been developed by the Monarch Machine Tool Company, of Sidney, Ohio. When provided with a four-cut cycle, there is no reasonable limitation on the amount of stock removal. However, the machine may also be supplied for two-cut or one-cut cycle work only, if that is the requirement. The Monarch "Air-Gauge Tracer" system, which operates on the precision air gauging principle, controls the hydraulically powered tool slide from a master template. The stylus pressure against the template is only 5 oz to 6 oz, and the accuracy of template shape is reproduced easily within plus or minus 0·001in.

The front carriage feed and traverse are accomplished hydraulically by a cylinder mounted in the apron. Feed rates are infinitely variable from 1in to 40in per minute and carriage traverse is at 200in per minute, while the traverse is at 90in per minute, both hydraulically actuated. An adjustable positive stop controls the maximum traverse of the facing and forming slide. All cycle valving is manifold-mounted, and compensated feed rate controllers permit a precise presetting of all feeds.

Five different feeds are available to the carriage for all cycles. When equipped with a two-speed motor drive, one additional feed is provided for the low side cut. A feed meter on the control panel registers the front feed in use at all times. The four-cut cycle machines have a selector switch for three-, two- or one-cut operation. The two-cut cycle lathes may be used either as one- or two-cut cycle machines. Three spindle speed ranges are offered, the highest of these having a top speed of 2760 r.p.m. A two-speed motor drive may be used advantageously where there is extreme diameter variation or when some part of the cut requires an exceptionally low speed. Either motor speed may be made operative automatically at the desired point in the cycle. The drive motor has 30 h.p. capacity.

For auxiliary machining operations, a rugged rear-mounted facing and forming slide is supplied. It may be timed to take its cut as demanded by the nature of the workpiece. The tailstock has an air-actuated spindle and a heavy-duty, anti-friction centre. Lubrication is completely automatic with a mist system applied in both the headstock and the tailstock. The machine is available in 18in, 30in and 42in centre distances.



"Mona-Matic" production lathe with four-cut cycle and hydraulically powered front carriage and rear slide

BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

ELECTRICAL ENGINEERING

840,840. July 9, 1958.—Overload Protection for Lifts, Otis Elevator Company, 260, Eleventh Avenue, New York 1, State of New York, United States of America. (*Inventors: Arthur Ennis Prince and David Carl Larson.*)

This invention relates to a system of overload protection for electric circuits, and is described with particular reference to lift installations. In overload protection it is undesirable to actuate the overload device in response to transient overload conditions. To prevent such actuation, a time delay is provided. It is the object of this invention to provide an inverse time overload protective system which is economical in construction, may be readily adjusted, is reliable in operation, and minimises maintenance.. The invention is especially applicable to multiple overload protection, such, for example, as is employed in variable voltage systems in which a d.c. work motor is supplied with current from a variable voltage d.c. generator, in turn driven by a two or three-phase a.c. motor. Such systems are extensively used in elevator installations. As applied to such a system, according to the preferred arrangement, three overload current coils are provided, one in the generator armature-motor armature loop circuit so as to be subject to the current flow between the generator and motor, and the other two connected respectively in two of the supply lines to the generator driving motor so as to be subject to current flow in the circuits of this motor. These coils act, upon overload current flow in any one of them or in any combination of them, to cause operation of switching mechanism to disconnect a restraining coil from its source of supply. The restraining coil acts, subject to the discharge of a capacitor, to oppose the action of the overload coil or coils until the decreasing opposing force exerted is exceeded by the force exerted by the overload coil or coils. When this occurs, the overload coil or coils act through a member common thereto to exert force for actuating contacts to disconnect the driving motor from its supply lines. Another example of multiple circuit protection to which the invention is applicable resides in systems employing a three-phase, two-speed a.c. work motor, also extensively used in elevator installations. In such cases, two overload current coils are connected respectively in the a.c. supply lines to the work motor and the other operating coil is arranged as a potential coil and connected in circuit so long as operation is on the slow-speed winding. Thus the device acts to limit the time of operation on the slow speed winding. In the case of single-speed, two or three-phase a.c. work motor installations, two overload current coils are used connected respectively in a.c. supply lines. Thus, with all such applications, overload protection is provided which, upon occurrence of overload conditions, causes disconnection of the mechanism being protected upon expiration, after the overload condition arises, of a time interval which varies inversely with the amount of the overload current. Temporary overload conditions which are not severe do not cause actuation of the protective device, yet an overload, if severe enough, such as a short circuit, can cause instantaneous operation.—*July* 13, 1960.

841,702. May 16, 1956.—Device for Barring Turbo-Alternators, Licentia Patent-Verwaltungs-G.m.b.H., 31-32, Hohe Bleichen, Hamburg 36, Germany.

The invention relates to a device for turning the rotors of a turbo-machine coupled to an electricity generator. Such turning devices are needed, in particular, for turbo-machines which are exposed to very high temperatures. Before the machine is started, and particularly when it is running down, i.e. on shutting off the working medium, the rotors must be turned in order to prevent distortion by unequal heating or cooling. The invention consists in that the coupling flanges which connect the turbine and the generator are constructed in the form of the rotor of an electric motor, and a stator which co-acts with the rotor is fixed to the housing or the base of the turbo-machine. It is an advantage that the structural length of the turbo-machine is not affected by the device according to the invention. Toothed-wheel gears are avoided thus saving a not inconsiderable part of the costs of a turning device. The rotor formed by the coupling flanges may be constructed in the form of a slip-ring rotor or cage rotor for a three-phase motor. It is further proposed that a ring consisting of laminated iron should be mounted on the coupling flange in order to improve the efficiency of the three-phase motor. It is also possible to provide the rotor consisting of the coupling flanges with a winding for a d.c. motor. For ease of assembling the stator casing round the rotor, it is proposed that this should be divided along a plane through the rotor axis or at right angles to the rotor axis. The multipolar three-phase winding in the stator is arranged in such a manner that each radial half of the stator carries half the number of poles.—*July* 20, 1960.

ELECTRIC HEATING

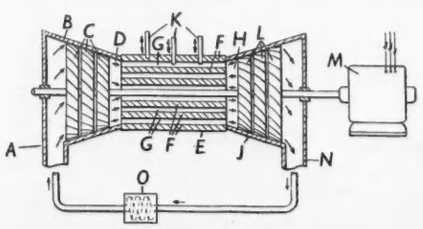
842,000. June 14, 1956.—Thermostatic Control of Electric Storage Heaters, Percy Howard Greer, 22, Greenfield Road, Sutton, County Dublin, Southern Ireland, and Unidare, Ltd. (formerly Aberdare Electric Company, Ltd.), Unidare Works, Jamestown Road, Finglas, County Dublin, Southern Ireland.

According to this invention, a thermostatic switch associated with the heating circuit of an electrical storage heater is arranged with the temperature-responsive element of the thermostat between and in immediate proximity to the outer surface of the insulating jacket and the metal outer casing of the heater. Preferably the element of the thermostat, the temperature of which determines the operation of the switch, is in thermal contact with the casing. When the storage heater is in operation, heat is lost from the casing and it has been found that by suitable adjustment of the operating temperature at which the thermostat is set, most economical use of the charging current may be obtained. Thus if during the "off" period, the dissipation of heat from the heater core has been relatively small, the temperature at the surface of the heater will also be relatively high and when the charging period commences it will be raised to the temperature at which the thermostat operates fairly quickly, well before the core has reached its maximum permitted temperature. The relatively limited quantity of heat thus applied during the time that the charging current is allowed by the thermostat to operate will probably be sufficient to maintain the desired room temperature by slow dissipation of heat from the heater during the "off-current" period. On the other hand, if the room temperature falls to an undesired extent and the temperature of the core of the heater is not sufficient to maintain the room temperature by transfer through the heater jacket, the temperature at the exterior of the jacket will fall so that the thermostat will permit charging current to flow during the "on current" period of the mains supply until such time as both the core temperature and the ambient air temperature have risen, with corresponding rise in the surface temperature of the heater. In other words, if due to low air temperature the surface of the heater remains relatively cool irrespective of the temperature of the core, more heat will be supplied to the core, which will thus be better able to meet heavy demands during the subsequent "off-current" period; whereas if the surface temperature of the heater is relatively high, due, for example, to slow rate of heat dissipation to relatively warm ambient air, the charging current will be cut off by the thermostat at an earlier stage of the "on-current" period and without prolonged supply of heat to the core.—*July* 20, 1960.

NUCLEAR POWER

841,972. August 14, 1958.—Nuclear Energy Turbine, Esso Research and Engineering Company, New Jersey, U.S.A.

This invention proposes a nuclear energy closed cycle gas turbine operating with a gaseous working fluid which contains fissile material. Referring to the drawing, a working fluid such as helium containing



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uranium hexafluoride is passed by line *A* to the inlet of a compression zone in an axial flow gas turbine. The gaseous medium contains sufficient uranium 235 hexafluoride to give a C_p/C_v ratio of about 1·30. This blend contains about 15 mol per cent of UF_6 (U-235). The inlet pressure to the compression zone *B* is about 215 lb per square inch, and the inlet temperature is about 290 deg. Fah. The gas passes through compression zone *B* and is compressed by turbine blades *C* to a critical degree by the time it reaches inlet *D* to nuclear reaction zone *E*. The temperature at this point is about 900 deg. Fah., and the pressure is about 3000 lb per square inch. Nuclear reaction zone *E* comprises a chamber for the compressed gas to flow through and moderator disposed thereabout, and can take any one of several forms. As illustrated, it comprises a block of moderator material *F*, e.g. graphite, suitably encased in stainless steel and provided with conduits or passageways *G*. The compressed gaseous medium flows from inlet *D* through passageway *G*, and falls within the influence of the moderating material. The heat generated is taken up by the gaseous medium, increasing its enthalpy. The gaseous medium then flows from passageway *G* to inlet *H* of the expansion or turbine zone *J*, where the temperature is about 1050 deg. Fah. and the pressure slightly below 3000 lb per square inch. To aid in controlling the nuclear reaction, control rods *K* can be suitably disposed in the reaction zone. As shown, they are transverse to the axis of the turbine, but they could be parallel thereto. There can be disposed about the reaction zone suitable reflector materials, such as a circumferential heavy water shield. The gaseous medium heated in the nuclear reaction zone passes from inlet *H* through turbine wheels *L* of turbine zone *J*, supplying rotary thrust thereto, and is consequently reduced in enthalpy. The shaft *M* in this particular design extends through and connects with turbine wheels *C* to supply power thereto, and extends in the other direction to a mechanical power consuming device. The expanded gases flow from turbine wheels *L* to outlet line *N*. The gaseous medium at this point has a temperature of about 370 deg. Fah., and a pressure of about somewhat more than 215 lb per square inch. The gaseous medium is then recycled to the inlet of the compression zone, after reducing its temperature to 290 deg. Fah. and reducing its enthalpy, as by passage through a heat exchanger zone *O*. This heat exchanger zone can be used, for example, to generate steam for a conventional steam turbine. In a slightly modified system the moderator comprised a series of five concentric shells of zirconium hydride each approximately 2ft long and 1ft 7in thick and spread apart 6·7in from each other with a gas circulation of 3200 lb mol per hour and a uranium 235 consumption of 0·00275 lb per day, 5000 s.h.p. as delivered to the shaft *M* for utilisation by electric generator. At the same time 25,000,000 B.Th.U. of heat removed per hour by heat exchanger *O* could be used for other purposes. The zirconium hydride shells had an i.d. of 1·4in and an o.d. of 4·8in. In this embodiment 50 grammes of boron carbide in the form of movable rods were made immediately available to the nuclear reaction zone as a neutron absorbing material to maintain stable conditions. In a modification of the invention the gaseous medium or working fluid is compressed and heated through the agency of an opposed free-piston engine. Single free-piston engine designs can be used.—*July* 20, 1960.

COAL DISTILLATION

841,610. July 18, 1956.—Purifying Coal Distillation Gases, Heinrich Koppers G.m.b.H., 29, Moltkestrasse, Essen, Germany.

This invention relates to the purification of coal distillation gases containing small quantities of free oxygen by removing hydrogen sulphide and other acid impurities by scrubbing under pressure with an alkaline solution containing a catalyst. After scrubbing, this solution is usually treated with air to oxidise the hydrogen sulphide absorbed to elementary sulphur, which can be separated therefrom in any convenient manner. The alkaline solution can then be returned to the scrubber for further use. This after-treatment with air accounts for a considerable proportion of the cost of the purification process and it is the object of the invention to eliminate the need for this treatment. This is achieved by the use of a catalyst of the hydroxy- or polyhydroxybenzene class in such a quantity that the hydrogen sulphide absorbed by the alkaline solution is wholly or substantially wholly oxidised to form elemental sulphur during the scrubbing operation and is subsequently removed from the alkaline solution under reduced pressure before the solution is returned to the scrubber or further use. The quantity of catalyst used depends

upon the hydrogen sulphide and oxygen content of the gas to be treated and also upon the temperature and pressure and ranges from approximately 1·5 grammes to approximately 2·5 grammes per litre of solution.—*July* 20, 1960.

INTERNAL COMBUSTION ENGINES

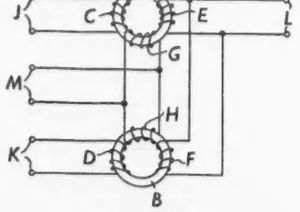
841,811. August 12, 1958.—RUNNING-IN OF INTERNAL COMBUSTION ENGINES, "Shell" Research, Ltd., St. Helen's Court, Great St. Helen's, London, E.C.3. (*Inventors: Albert Gordon Bell and Sidney Robert Epton.*)

This invention is particularly concerned with a method of running-in an engine in a short time or over a short distance, and under controlled contions. Under this method the engine is first run on a fuel containing an oil-soluble chromium salt of an organic acid at a concentration of 0·05 grammes and upwards of chromium per gallon of fuel until the engine has reached a satisfactory state of wear. The oil system and fuel supply of the engine are then drained preparatory to refilling and normal running. It is preferred to use a concentration between 0·1 and 2·5 grammes of chromium per gallon though greater concentrations, e.g. up to 10 grammes per gallon or even more, can be used for short periods and under close control. The use of chromium compounds of this kind has many advantages. The compounds employed, being oil-soluble, are readily dispersed through the fuel charge and are thus uniformly supplied to the engine during the running-in period. Furthermore, the chromium oxide and other relatively simple chromium compounds produced in the engine by the combustion of the fuel exert a rapid though gentle abrasive effect which reduces the unwanted asperities smoothly and rapidly, and produces a high polish on the working surfaces. It has been found that the chromium compounds are five or more times as effective as iron compounds used in a similar way. In this respect the invention is of particular advantage in engines employing chromium-plated or otherwise specially hardened piston rings, upon which other types of running-in aids either have little effect or have an effect at the expense of excessive wear on other and less resistant working surfaces of the engine. Any suitable chromium salts of organic acids may be used which are oil-soluble and will decompose under the conditions of combustion within the engine. Particularly suitable acids are those of sufficient molecular weight or hydrocarbon chain length for the salts to be soluble in the fuel employed. Examples of such salts are chromium naphthenates and chromium salts of alkylated salicyclic acids; the last mentioned compounds are particularly advantageous in spark-ignition engines as being substantially free from a tendency to give rise to unwanted engine deposits, especially in the inlet ports and manifold of the engine.—*July* 20, 1960.

ELECTRONICS

841,622. October 29, 1956.—MAGNETIC SWITCHING CIRCUITS, Ericsson Telephones, Ltd., 22, Lincolns Inn Fields, London, W.C.2. (*Inventor: Aryl Leib Freedman.*)

The present invention relates to switching circuits of the type usually referred to as an "and" gate. In a known switching circuit of this kind a difficulty is experienced in ensuring that the amplitudes of the operating pulses are such that a single applied pulse in one of the input windings is insufficient to saturate the core and that two (or more as the case may be) applied pulses are always necessary. Furthermore, the circuit has the disadvantage that the design of the core and its associated windings is dependent upon the number of input circuits to be provided for. In the circuit according to this invention, as shown in the drawing, the "and" gate shown comprises



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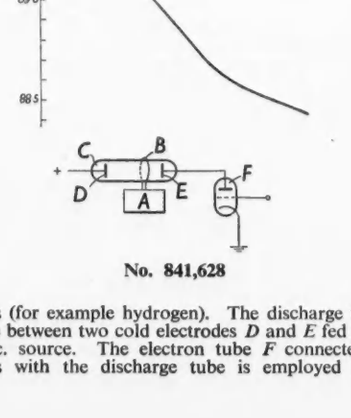
two annular shaped ferro-magnetic cores *A* and *B*, each provided with an input winding *C* and *D* respectively, an output winding *E* and *F* respectively, and an advance winding *G* and *H* respectively. The input windings are connected to separate pairs of input terminals *J* and *K* respectively, whereas the output windings are connected in parallel with one another to a common pair of output terminals *L*. The advance windings are connected in parallel with one another to a pair of terminals *M*. The material constituting the annular cores may be of any suitable kind having a hysteresis curve which is of the shape known in the art as rectangular. The cores may, for example, be of ferrite material. In operation, pulses are applied to the input terminals in dependence upon the operation of a controlling circuit connected thereto. If an impulse appears in only one of the windings *C* and *D* the associated output winding is shunted by the output winding of the other core and hence the energy of the pulse appearing in the first output winding is substantially completely dissipated in the other output winding and its associated core and input winding. On the other hand, if pulses are applied simultaneously to the input terminals neither of the output windings can shunt the other whereby a voltage pulse appears across the output terminals. For some purposes it is not desired to make use of this pulse and the advance windings are used for the purpose of restoring the state of magnetisation of the cores to a predetermined datum prior to the application of further pulses to the input circuits. For this purpose the terminals *M* are connected to a source of pulses which can be applied at predetermined instants. Under these conditions the magnetic cores are set to their alternative magnetic condition by the simultaneous application of pulses to the input terminals, on the application of a pulse to the advance terminals *M* to the state of magnetisation is reversed to its datum condition whereby an output pulse appears across the output terminals. A circuit such as that described, wherein the cores are each 3mm in diameter and such that an input signal of 1A turn is sufficient to change its state from the datum state to the alternative state, in the absence of the shunting effect of the other core, has been investigated. It was found that an input signal of 1·85A turns could safely be applied to the input winding of one core without causing both cores to change their states and thus produce an output voltage. The figure stated above is by no means the extreme upper limit in the amplitude of input signal which may be applied to one core for the circuit to function, but is the limit up to which reliability is ensured.—*July* 20, 1960.

841,628. January 4, 1957.—FREQUENCY-MODULATED OSCILLATOR, Directia Generala a Radiodifuziunii, Str. A St. Popov No. 62, Bucharest, Roumania.

There exist at present two principal methods of frequency-modulating radio transmitters, namely by means of a reactance tube and by previous phase modulation. The disadvantage of the present methods is that they necessitate a frequency multiplication of the order of 10-60 (in the case of the reactance tube method) or of several thousands (in the case of phase modulation). Moreover, difficulties arise in producing a large frequency swing for directional transmitters and the limitation of amplitude modulation calls for extreme care. The present invention therefore proposes the use of gas discharge tubes. If one of the elements of a tank circuit (inductance coil or condenser) is completely or partially introduced into an ionised gas, the electrical properties of the element concerned and the resonance frequency are varied accordingly in dependence upon the degree of ionisation of the gas. If the inductance of a tank circuit consists of one or more turns wound on a gas discharge tube, the resonance frequency varies in dependence upon the discharging direct current *I* in accordance with the curve shown in the upper drawing. This curve has a portion which shows a linear dependence between the discharging current and the resonance frequency. In the lower drawing, in order to effect the frequency modulation of an oscillator *A*, the turns *B* of the inductance of the tank circuit are wound on a discharge tube *C* fed with direct current and filled with



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a gas (for example hydrogen). The discharge takes place between two cold electrodes *D* and *E* fed from a d.c. source. The electron tube *F* connected in series with the discharge tube is employed as a limiting and regulating resistance. The discharging current is adjusted to a value which brings the operating point on to the rectilinear portion of the curve. The control grid of the electron tube is controlled by the low-frequency voltage, whereby a ripple current is produced in the gas discharge tube and the oscillator is frequency-modulated.—*July* 20, 1960.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

PROCEDURES FOR OBTAINING PROPERTIES OF STEEL AT ELEVATED TEMPERATURES

PART I: PROOF STRESS

No. 3228: 1960. Price 3s. This publication forms part of a series of procedures for obtaining the data necessary to determine the properties of steel at elevated temperatures. Standard procedures ensure that the data obtained will be based on a common method—a prime requisite where the resultant figures are to be included in national standards acceptable to purchasers of steel and of equipment made from it, both in the United Kingdom and overseas.

The specific scope of this part of the standard is to specify the procedure for obtaining the range of values of any selected proof stress between 0·1 and 0·5 per cent for a selected steel at elevated temperatures. Requirements are specified for the method of test; selection of the samples; test conditions; and the presentation of results.

WHEEL PAIRS FOR LOCOMOTIVES AND ROLLING STOCK (DIMENSIONS)

PART 2: WHEEL CENTRES AND MONOBLOC WHEELS

No. 3117: 1960. Price 4s. 6d. This new publication is one in a series dealing with complete wheel pairs for locomotives and rolling stock (Parts 1-4 dealt separately with: axles, tyres, Gibson ring tyre fastening; machining and assembly). To enable the least number of sizes of wheel centres and monobloc wheels to be manufactured, the standard lays down a limited number of preferred leading dimensions. The following type of wheel centre with separate shrunk-on tyres are dealt with: rolled steel disc; cast steel spoked; cast steel web (normally for small diameters only); and cast steel to special design.

An appendix to the standard gives a list of metric equivalents; and the text of the specification proper is amplified by three full-page, fully annotated diagrams.

Catalogues and Brochures

MIDLAND SILICONES, Ltd., 68, Knightsbridge, London, S.W.1.—Booklet entitled "Silicone Lubricating Fluids and Greases."

GREENWOOD'S AND AIRVAC VENTILATING COMPANY, Ltd., Beacon House, Kingsway, London, W.C.2.—Leaflet illustrating multi-panel movable louvres constructed in aluminium.

PILOT WORKS, Ltd., Manchester Road, Bolton, Lancs.—Brochure describing the company's 3, 9, 12 and 15-ton hydraulic presses; standard hydraulic cropper and angle iron hydraulic cropper.

DUST CONTROL PROCESSES, Ltd., 161, Clarence Street, Kingston-upon-Thames.—Brochure giving details of a fully automatic fabric filter specially designed for application in heavy industries.

COBURN ENGINEERS, Ltd., Coburn Works, Peasmarsh, Guildford, Surrey.—As a supplement to its main sliding door gear catalogue the company has issued an illustrated guide to overhead runways.

WILD-BARFIELD ELECTRIC FURNACES, Ltd., Elecfurn Works, Otterspool Way, Watford By-Pass, Watford, Herts.—Illustrated brochure containing technical descriptions of laboratory muffles and small furnaces.

BRITOOL, Ltd., Britool Works, Bushbury, Wolverhampton.—Illustrated catalogue of 164 pages describing the many different wrenches and other tools manufactured by the company. A separate retail price list is included.

Forthcoming Engagements

Secretaries of Institutions, Societies &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated*

BIRMINGHAM SCIENCE MUSEUM

Thurs., Sept. 29.—Museum of Science and Industry, Newhall Street, Birmingham, 3, "Live Steam Operation of Five Engines," evening until 9 p.m., additional to regular "Steam Week-ends."

BRITISH INTERPLANETARY SOCIETY

Mon. to Sat., Aug. 15 *to* 20.—Royal Institute of Technology, Stockholm, Sweden, Eleventh International Astronautical Congress.

INSTITUTE OF METALS

Tues., Aug. 16.—17, Belgrave Square, London, S.W.1, "The Physical Nature of Plastic Flow," J. J. Gilman, 6.30 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Tues., Aug. 30 *to Sat., Sept.* 3.—The University College of North Wales, Bangor, Annual Conference, 1960.

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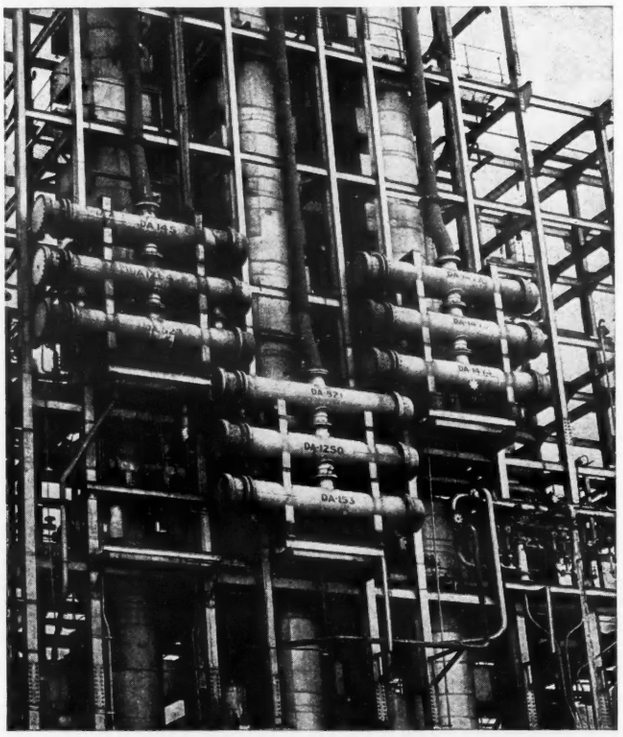

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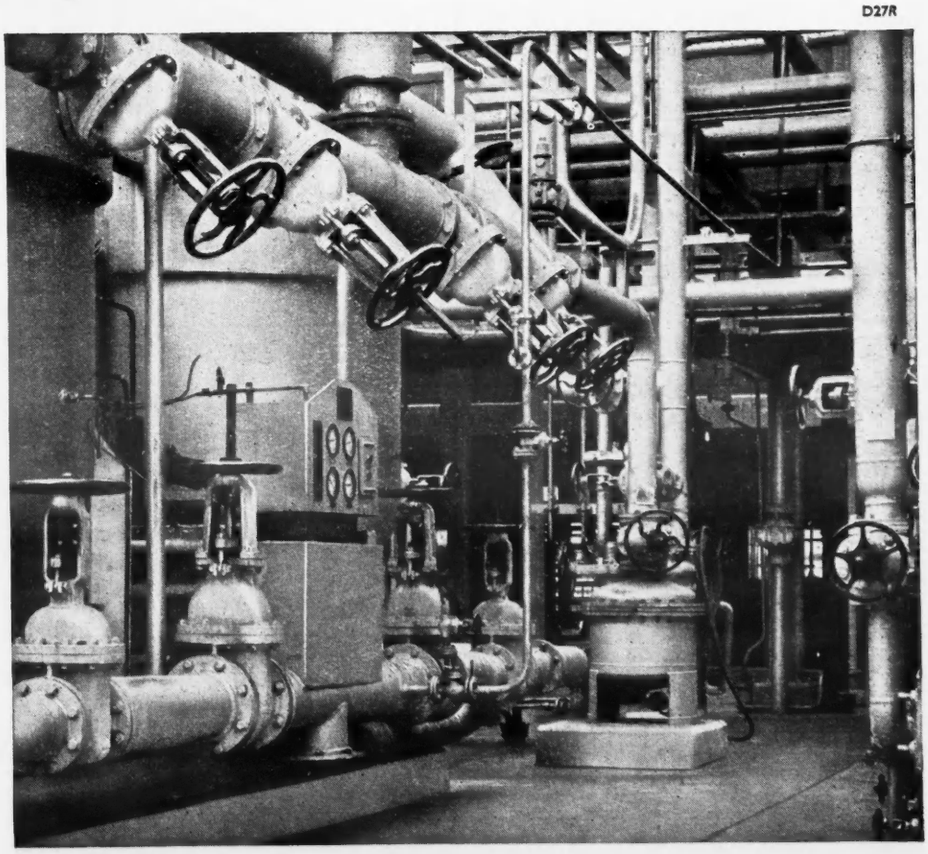
With the recent completion of yet another Olefine Plant at the Wilton Works of Imperial Chemical Industries Limited, there are now three in operation. In all of them Crane valves are performing duties under arduous conditions (extremes of temperature). In the plant illustrated here Crane steel valves up to 16-inch are employed. Industry is looking more and more to Crane valves for performance and dependability. The Crane reputation is founded on modern production methods, individual testing at the factory and the high grade materials which go into every one of the Crane products. This Plant was designed and installed by Kellogg International Corporation.



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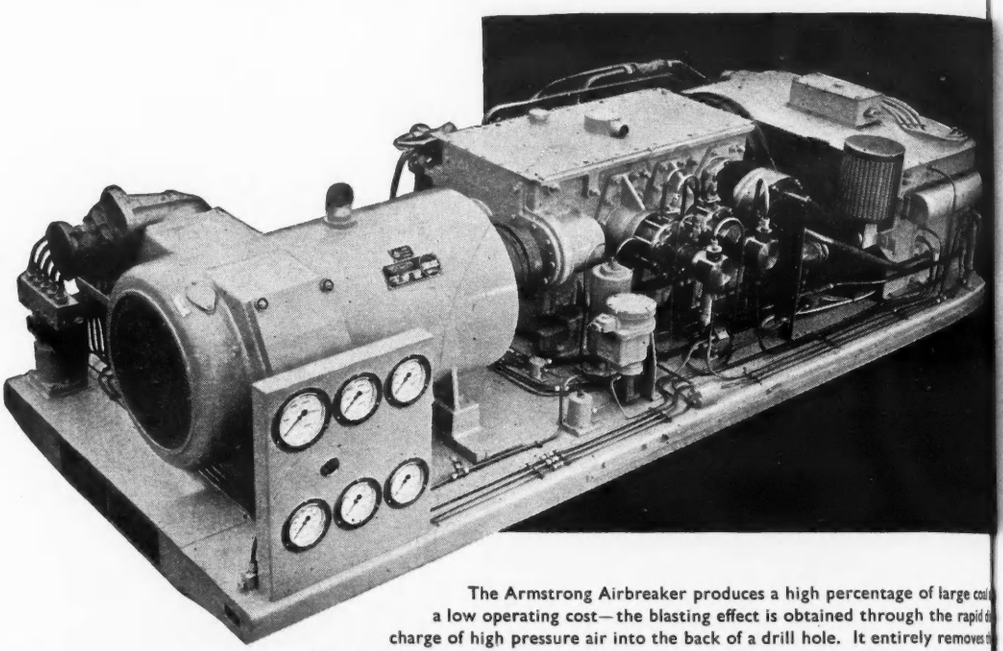

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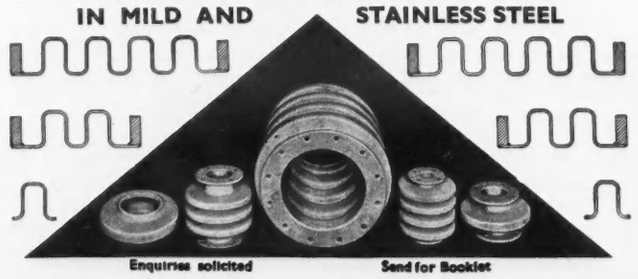

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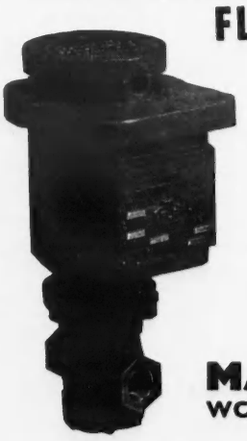

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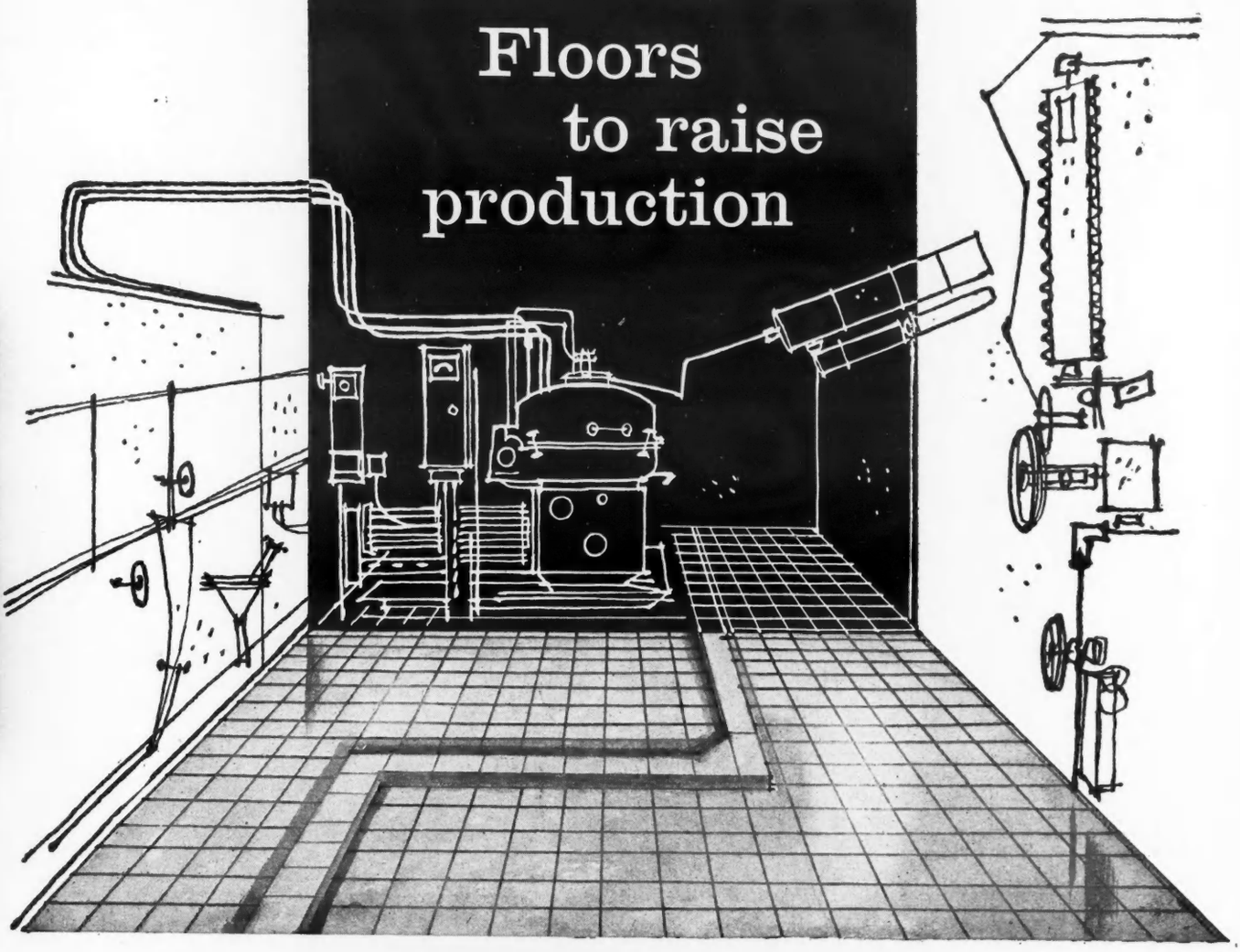
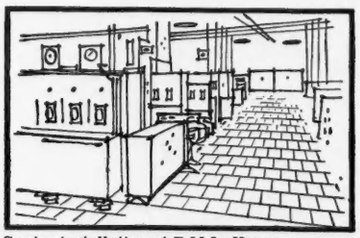
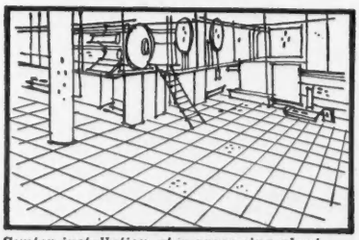




Semtex installation at E.M.I., Hayes.



Semtex installation at a processing plant of the Nestlé Co., Ltd.

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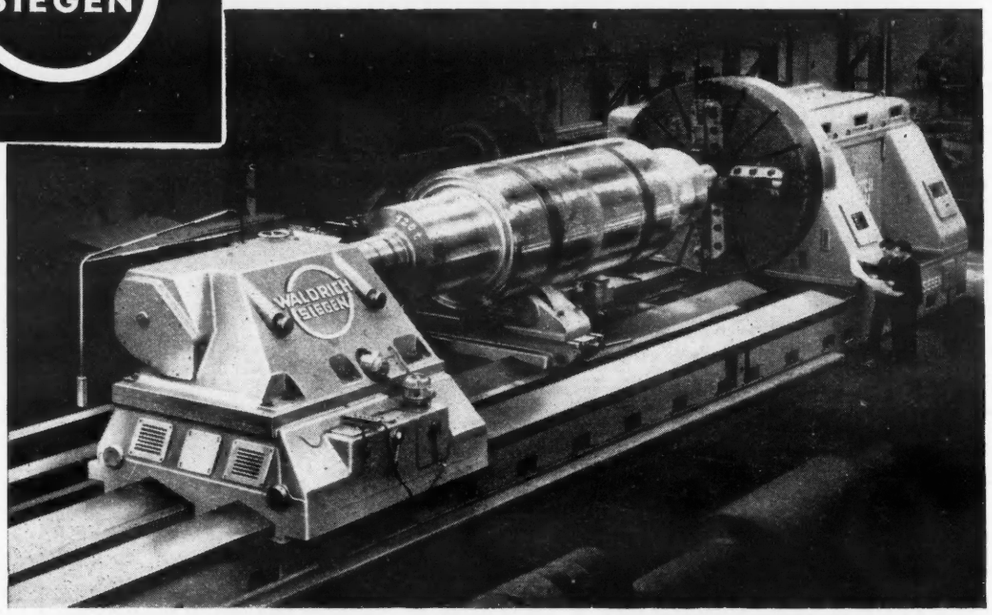

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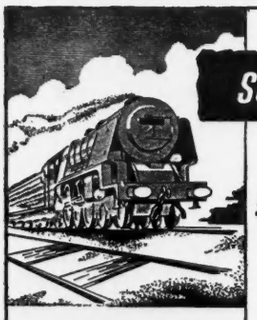

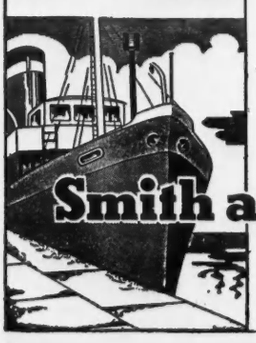

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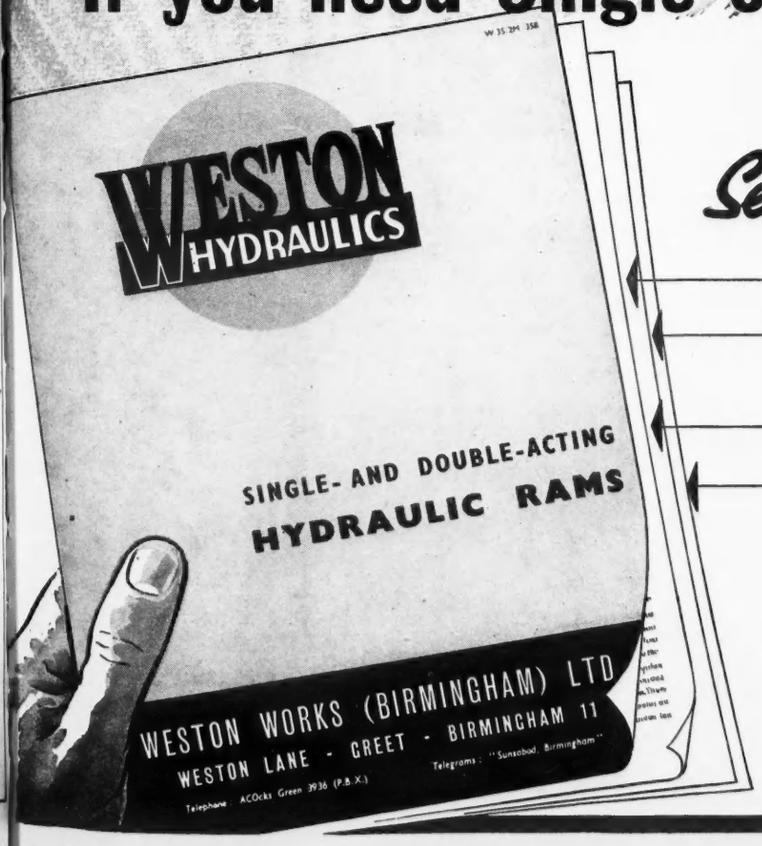

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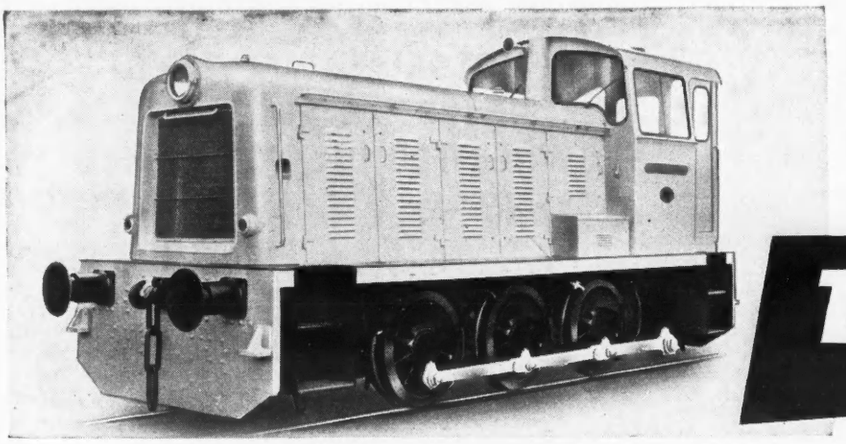

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Wheel arrangement 0-6-0
Dorman 6QA diesel engine 208 H.P. at 1300 r.p.m.
Weight 33·5 tons
Starting Tractive Effort 17,860 lbs.

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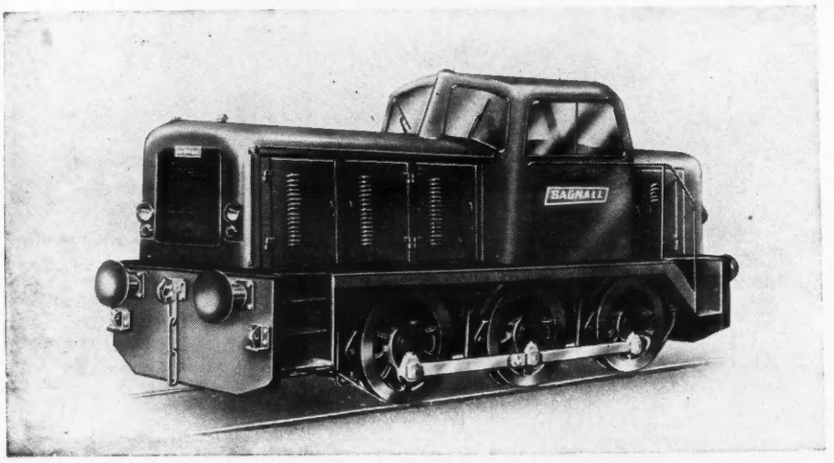

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Wheel arrangement 0-6-0
Dorman 6QAT diesel engine 342 H.P. at 1800 r.p.m.
Weight 48 tons
Starting Tractive Effort 32,300 lbs.

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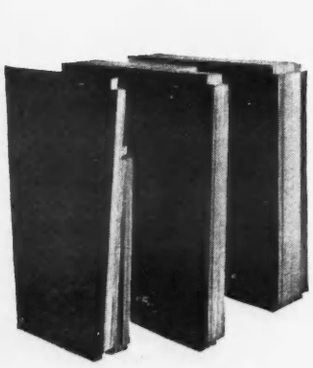

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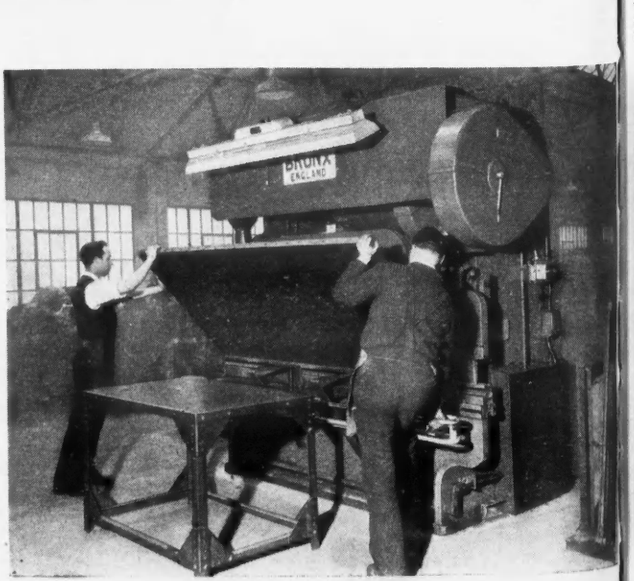

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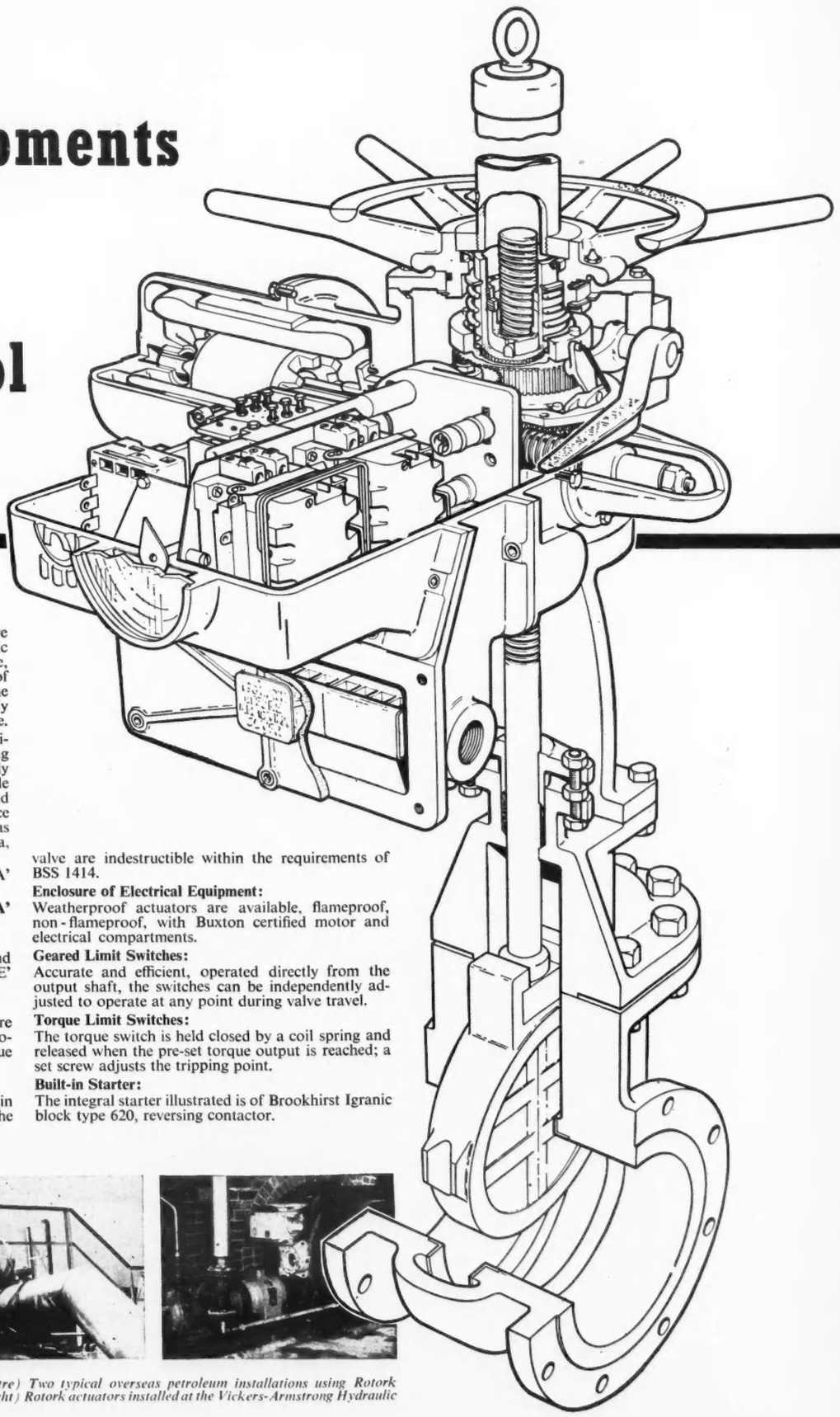
New developments in Rotork valve control



Valve manufacturers and users all over the world have helped Rotork develop their new series of electric actuators — the 'A' range. Such practical advice, coupled with Rotork's comprehensive experience of valve control, ensures that the 'A' range offers the most competent method available for automatically controlling any size or type of valve from any distance.

An entirely new manufacturing and selling organisation has been created to keep pace with the growing international demand for Rotork actuators. Highly competitive prices and good deliveries on a world-wide scale are assured by the overseas manufacturing and sales facilities now available in West Germany, France and Italy to augment U.K. production; as well as offices or agents in Holland, Switzerland, Australia, Canada and the Arabian Gulf.

A booklet covering every aspect of the Rotork 'A' range of actuators is available on request.

Outstanding features of the Top Handwheel 'A' Type Actuator illustrated are:

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Squirrel cage, Stator/rotor unit, half hour rated and built to BSS 2613. Available with class 'A', 'B' or 'E' insulation.

Input Shaft:
Motor, worm and torque measuring spring pack are all on this common shaft, which slides in direct proportion to the torque transmitted to operate the torque switch to shut off the motor.

Housing:
All components taking the thrust load are housed in the base of the actuator. Those fixed directly to the valve are indestructible within the requirements of BSS 1414.

Enclosure of Electrical Equipment:
Weatherproof actuators are available, flameproof, non-flameproof, with Buxton certified motor and electrical compartments.

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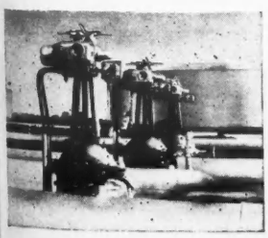
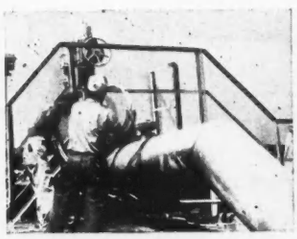
Accurate and efficient, operated directly from the output shaft, the switches can be independently adjusted to operate at any point during valve travel.

Torque Limit Switches:
The torque switch is held closed by a coil spring and released when the pre-set torque output is reached; a set screw adjusts the tripping point.

Built-in Starter:
The integral starter illustrated is of Brookhirst Igranic block type 620, reversing contactor.





(Left and centre) Two typical overseas petroleum installations using Rotork actuators. (Right) Rotork actuators installed at the Vickers-Armstrong Hydraulic Test Plant.

Rotork have a controlling interest in all types of valves!

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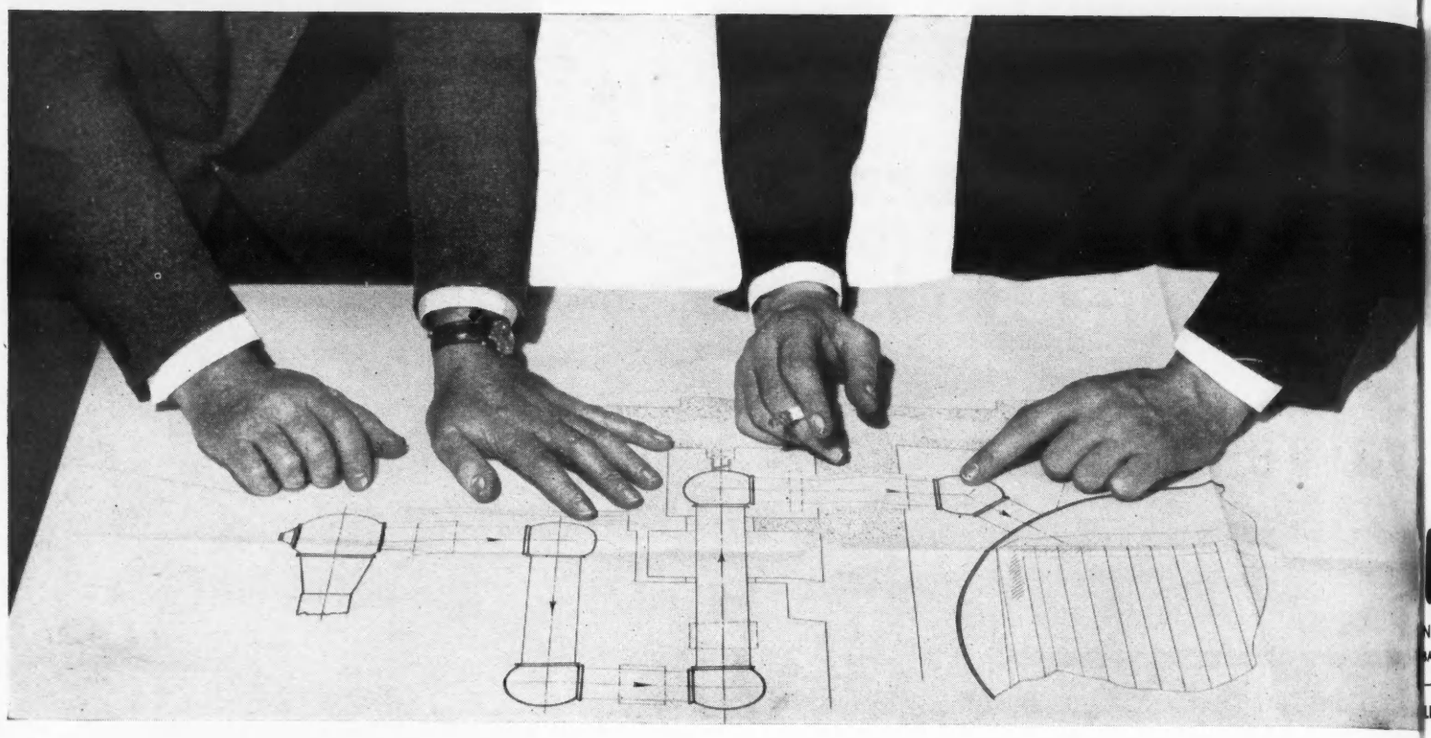
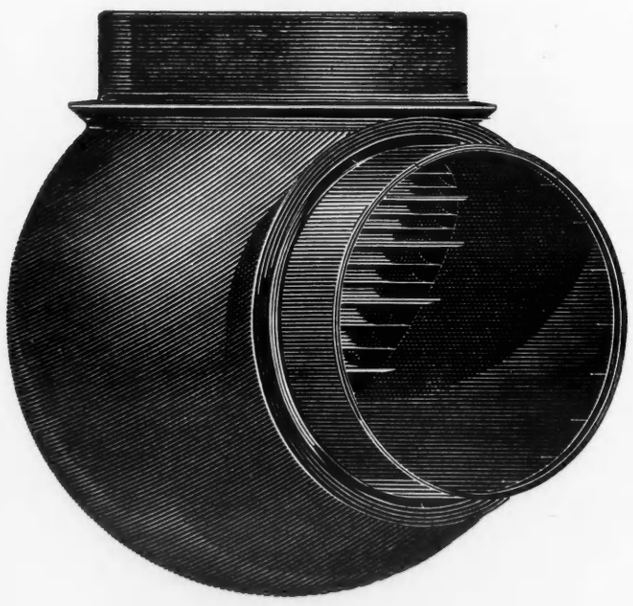


YOU COULD HEAR A PENNY DROP . . .



We spread out the drawings . . . an instant of surprised silence; then that gratifying sound. It is usually something like "Of course! Why didn't somebody think of that before."

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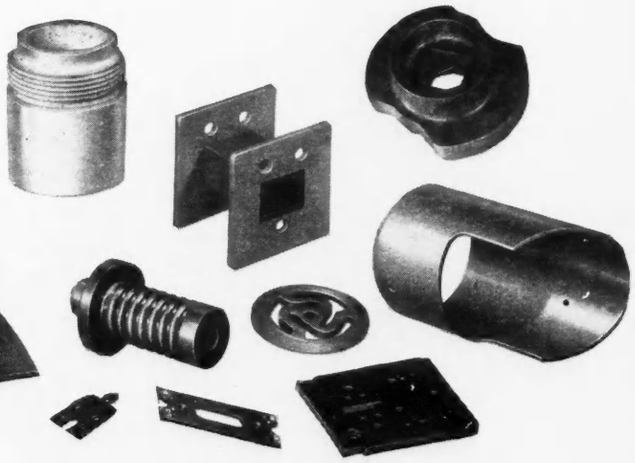

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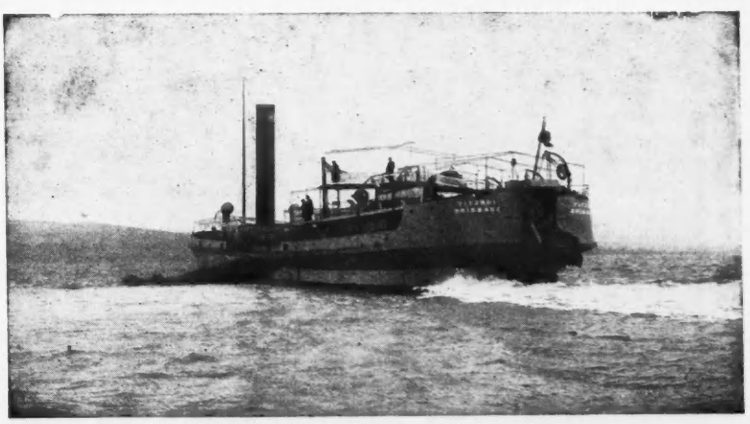

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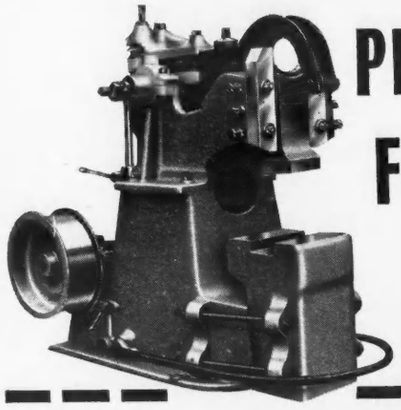

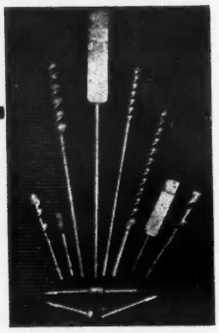

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Part of a £500,000 contract by Eagre—sidings and trackwork for Manvers Centralization Scheme (about three fifths of the project is shown in this aerial view). 9,000 tons of iron and steel, 40 miles of track, 230 turnouts were laid with no interruption of the existing traffic of the four collieries involved in the scheme.

Eagre also works for British Railways, the Gas Board, the United Steel Companies, Central Electricity Authority, etc. Materials are supplied from Eagre's own resources.

Whatever the magnitude of your siding requirements, consult—

EAGRE CONSTRUCTION CO. LTD.

East Common Lane · SCUNTHORPE · Lincs. Tel. 4513 (5 lines)

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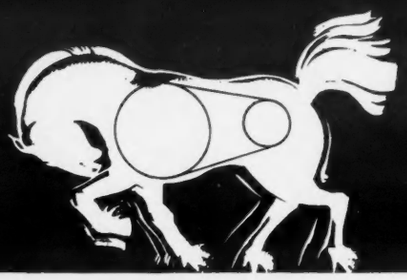
USE IT WHERE PRESENT DRIVE IS OVERLOADED.

USE IT WHERE MORE POWER IS REQUIRED IN THE SAME DRIVING SPACE.

USE IT WHERE V-BELT LIFE IS LIMITED.



MORE POWER IN THE SAME SPACE

TURNERS POLY-V (TRADE MARK) DRIVE

Advantages of THE "POLY-V" DRIVE

- "POLY-V" Belts transmit the same horse power as conventional V-belts on very much narrower pulleys.
- The unique design of "POLY-V" Drives reduce pulley widths to the minimum, resulting in maximum saving in space and reduction in pulley weight and costs.
- In a "POLY-V" Drive installation smaller pulley diameters can be used for the same speed ratios.
- Being single units, "POLY-V" Belts overcome matching problems associated with other multiple belt drives.
- Constant pitch diameters at all loads are maintained on "POLY-V" Drives.
- "POLY-V" Drives ensure minimum vibration and cooler running.
- "POLY-V" Drives provide greater interchangeability of belts and pulleys because there are only two belt cross sections instead of five for multiple V-belt drives.
- Longer lives of belts and pulleys are obtained on "POLY-V" Drives.
- "POLY-V" Belts are heat and oil resistant.
- "POLY-V" Belts, due to their small rib section, can be used in place of flat belts by cutting grooves in existing pulleys. "POLY-V" Drive conversions on stepped pulleys are particularly successful.
- Reverse idlers can be used without serious reduction in belt life.
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YOU can improve your power transmission applications

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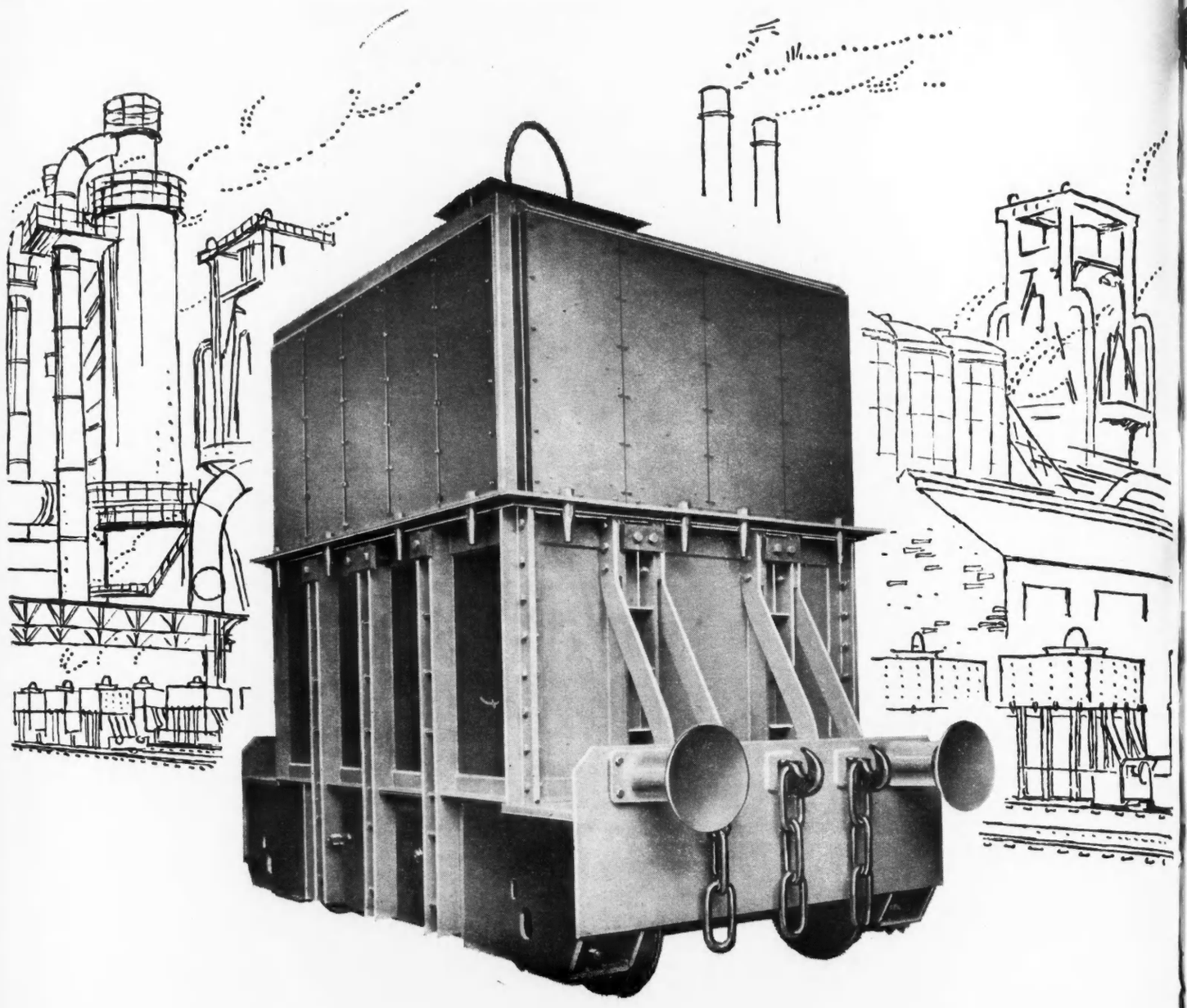

another THORNTON contract

This Insulated Transfer Car is one from a large contract recently supplied to Messrs. Colvilles Ltd. They are fitted with removable covers and insulated for conveying two 20 ton hot ingots. The Transfer Cars are made to suit British Railways standard gauge.

If it's a heavy engineering contract—try Thornton's first!

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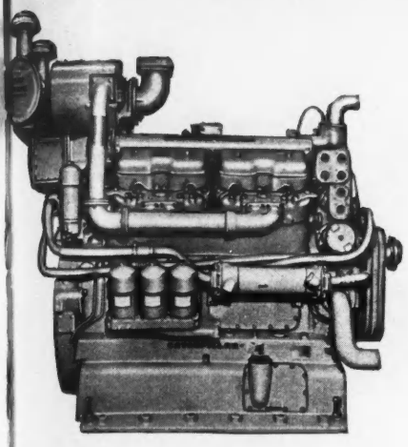
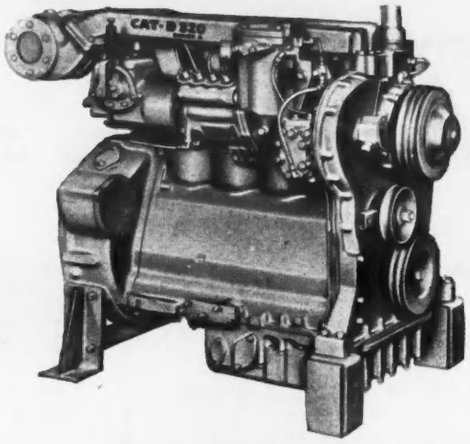
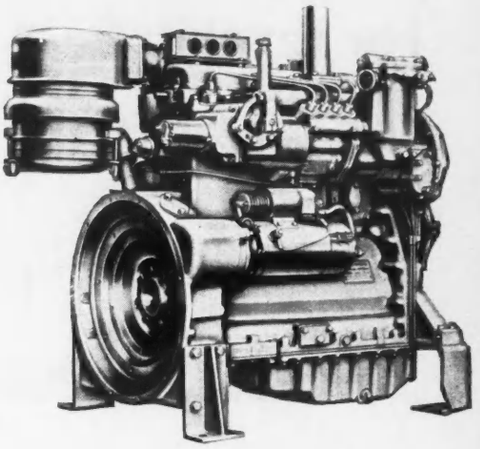


Caterpillar D375—
a heavy industrial power plant.



Caterpillar D320—Turbocharged Engine.



Caterpillar D311—
a lightweight industrial power unit.

YOUR CHOICE OF 10 BASIC HEAVY-DUTY DIESEL ENGINES UP TO 730 HP

A complete line of modern, dependable Caterpillar Engines is available to meet your every power requirement. The full range includes industrial, electric set and marine models with optional arrangements such as torque converters and spark ignition gas engines.
This means lower operating costs to you, because economy is lost when a large unit is used to handle a small load. The wide range of Caterpillar Engines enables you to match power to load exactly. Here are other reasons why Cat Engines will make your operation more profitable :

1. Superior design. Four-cycle design gives a longer effective power stroke and better cylinder lubrication for less wear and longer life.

2. Low-cost fuel. All Cat Engines can use a wide variety of fuels without fouling—fuels that are cheaper and easier to purchase. Large, single orifice injection valves resist clogging.

3. Ease of operation. Experienced mechanics or operators are not required since there are no operating adjustments necessary on Caterpillar Engines—you save on wages and costly maintenance equipment.

4. Proven long life. Some of the first diesels built by Caterpillar in 1931 are still running. You are assured of a profitable investment when you purchase a Cat Engine because they're built to last, and keep other equipment working full time.

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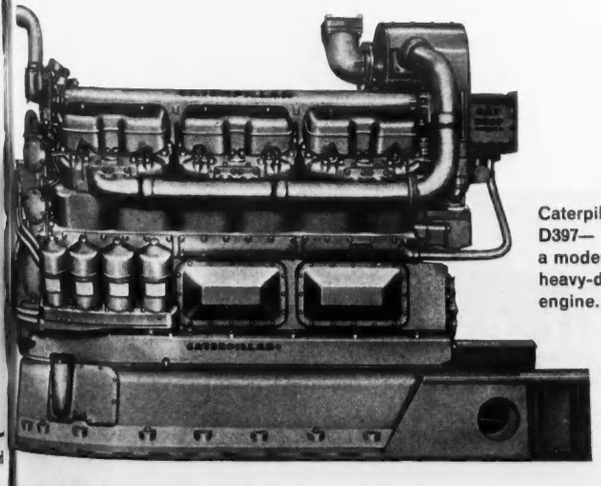
6. Keeps your equipment producing. Engine power is your key to high production at low cost. Cat Engines are built to rigid specification, have many exclusive features for extra dependability and full-time operation. Examples of these features—the aluminium alloy pistons with cast-in, cast-iron top ring band and wet-type cylinder liners for extra-long life. Caterpillar's Engine Representatives are fully qualified to recommend the right engine for your installation.



Caterpillar
D397—
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heavy-duty
engine.

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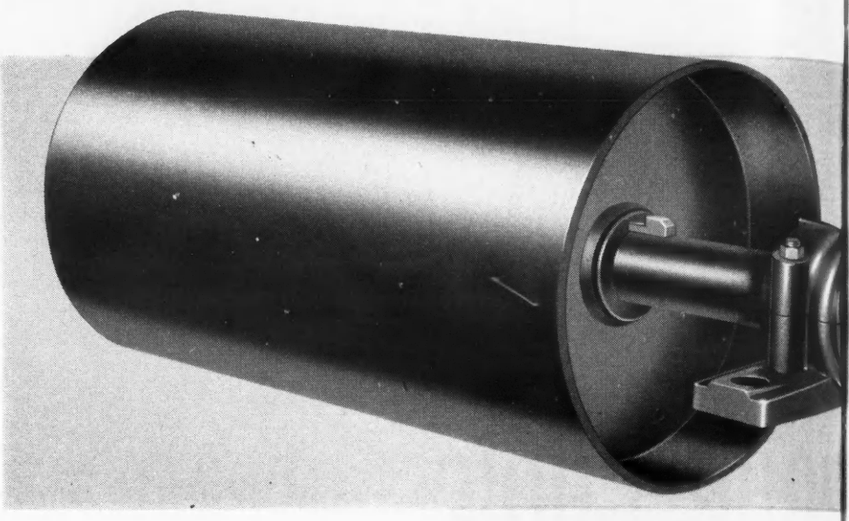
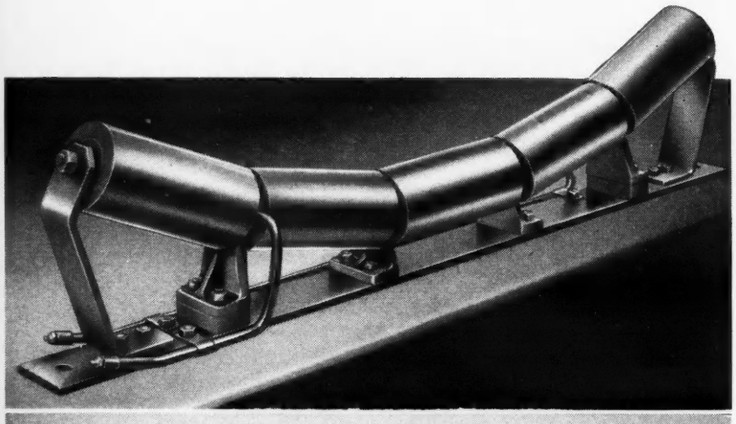
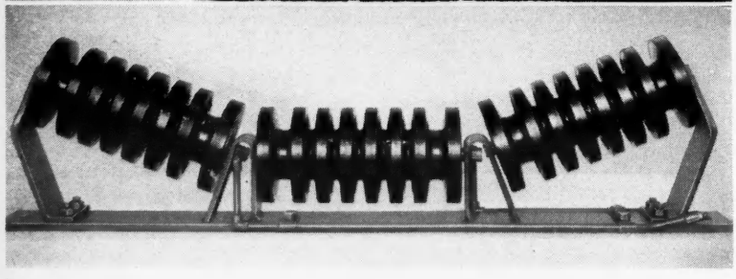
WESTWOOD DAWES Idlers and Pulleys

Welded Steel Pulleys

Available either flat or crown face in any combination of diameter, face width and bore. Pulleys only or assembled with shafts, bearings, tension slides, etc. All pulleys fully machined on face.







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All available with Grease-Packed and Sealed, Self-lubricating ball bearings or with external grease fittings.

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These are of great advantage when used on conveyors carrying wet and sticky materials as they prevent build-up of material on the return idlers, which in turn causes uneven running and belt misalignment.
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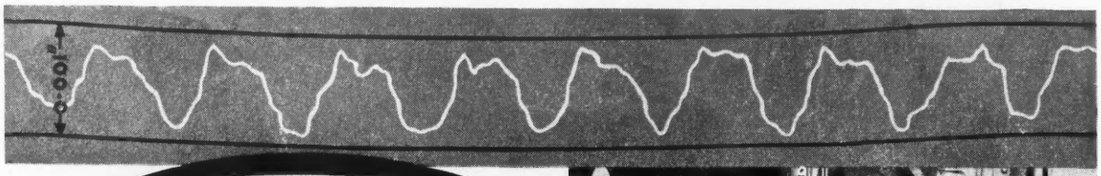
PRECISION GEAR-CUTTING



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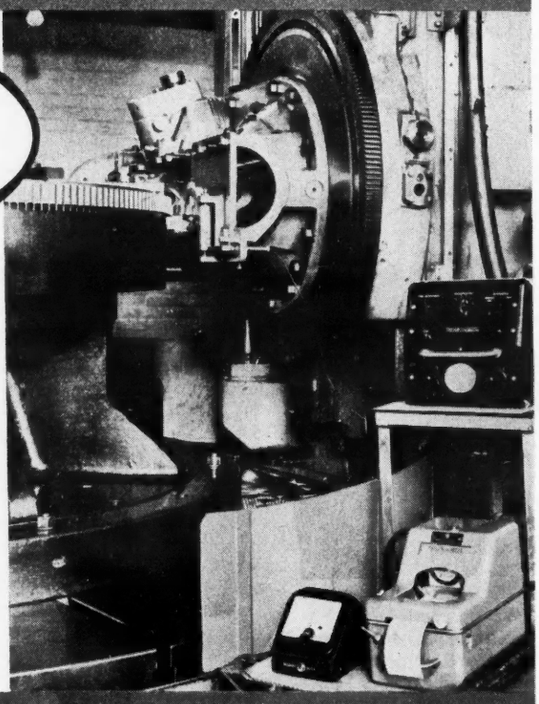
—better than Admiralty Class 1 Specification

The diagram shows a composite-error record (in part) of a precision-hobbed 4 D.P. spur ring of 56.250-in. P.C.D. Photograph shows gear ring on hobbing machine after cutting, with master gear spring-loaded in close mesh, and error record being taken. *Total error over 225 teeth—including master gear error—0.0012 in.*



A wide range of precision gear-cutting work can be undertaken by AEI . . .

- Enquiries invited for helical, spur, and worm gears, from 1-in. up to 120-in. diameter.
- Customers' blanks also processed if required.

For full particulars of this AEI service please write to Gear Sales, Rugby.

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"Spent more time on that machine than all the others in the shop. Now with R.T.D. tool life has gone up by as much as 200%.

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"Production difficulties not only forced our price up but ca delivery delays as well. Now with R.T.D. we're ahead of our com tors on both price and delivery."

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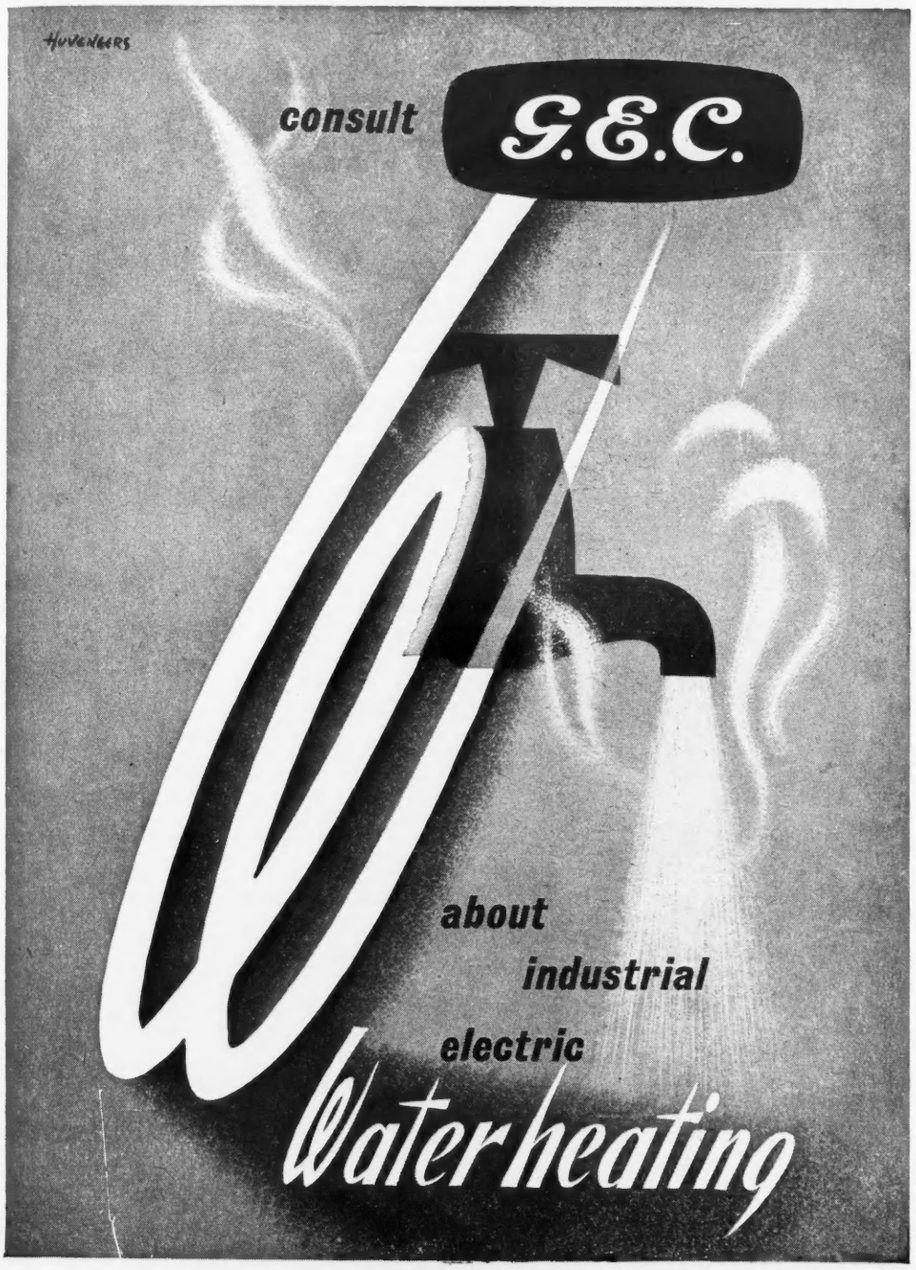

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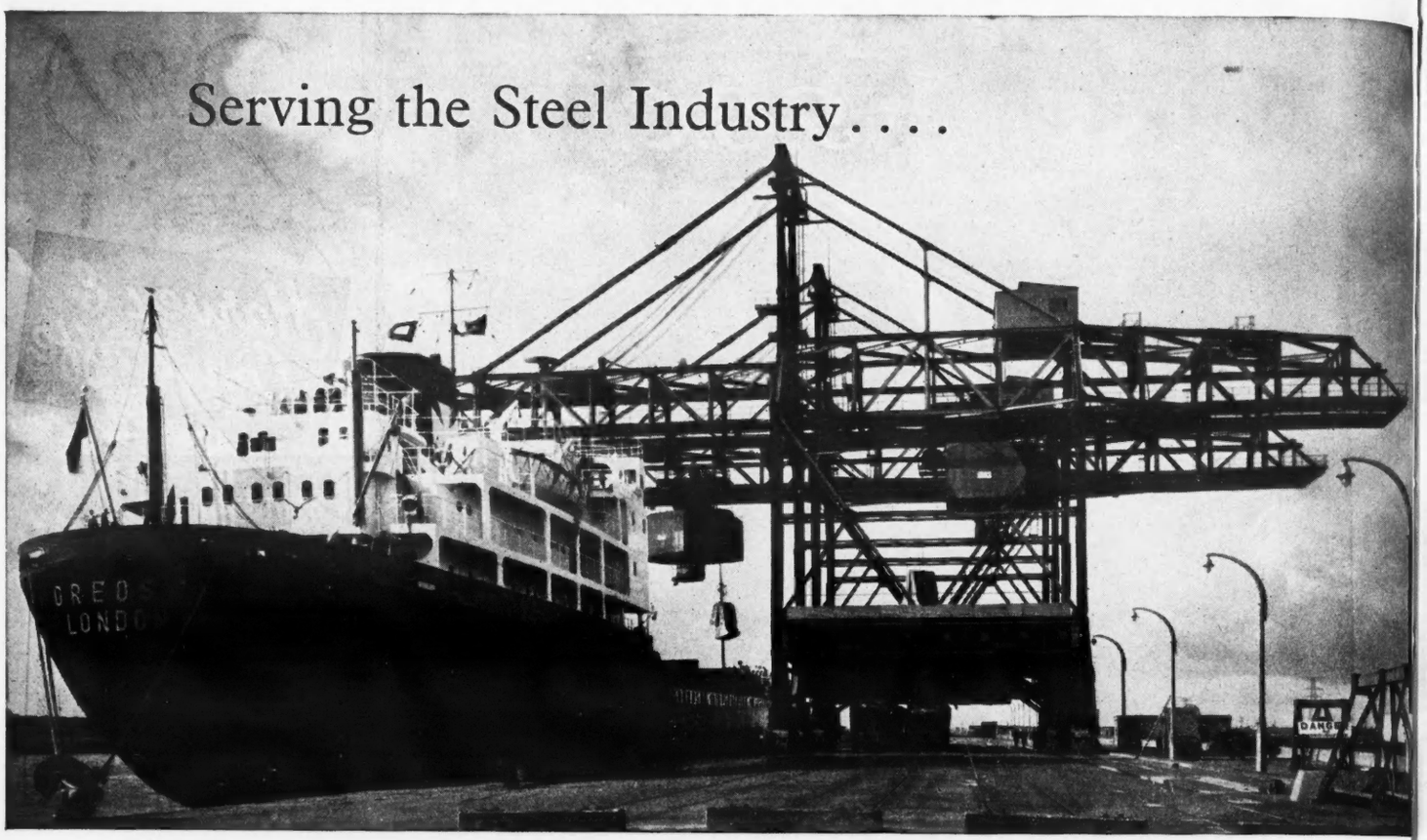
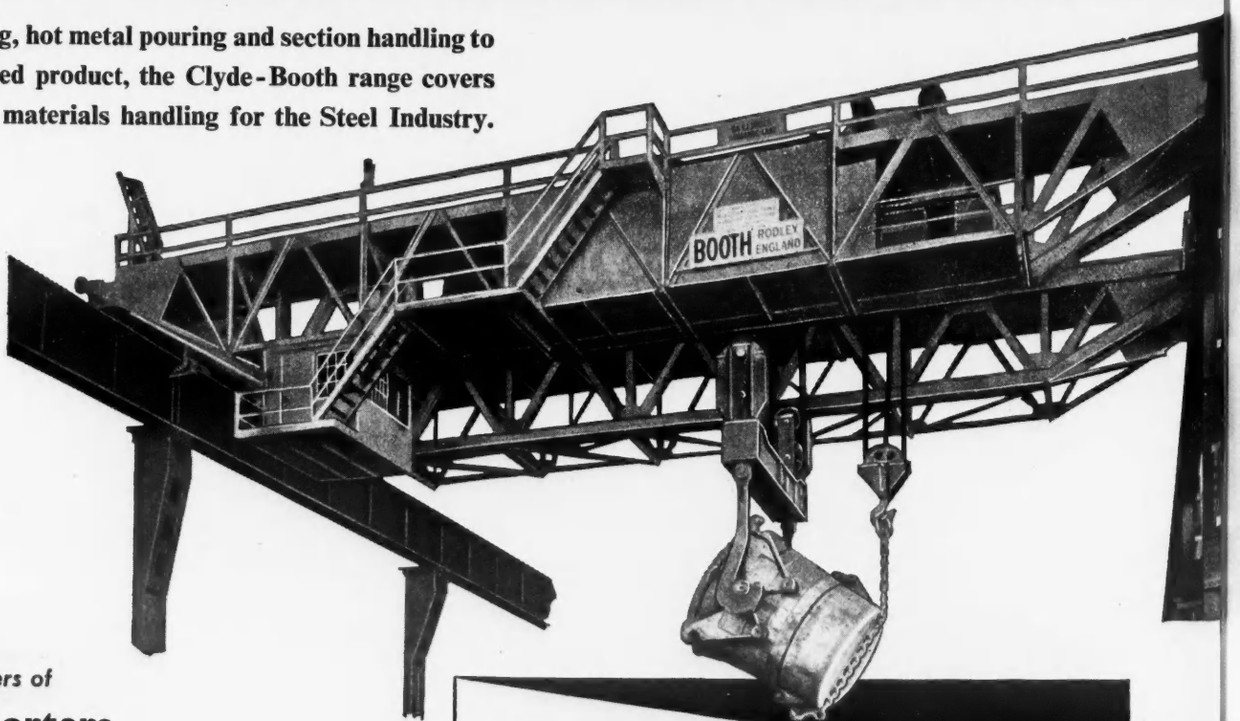


From ore unloading, hot metal pouring and section handling to shipping the finished product, the Clyde-Booth range covers the field of heavy materials handling for the Steel Industry.



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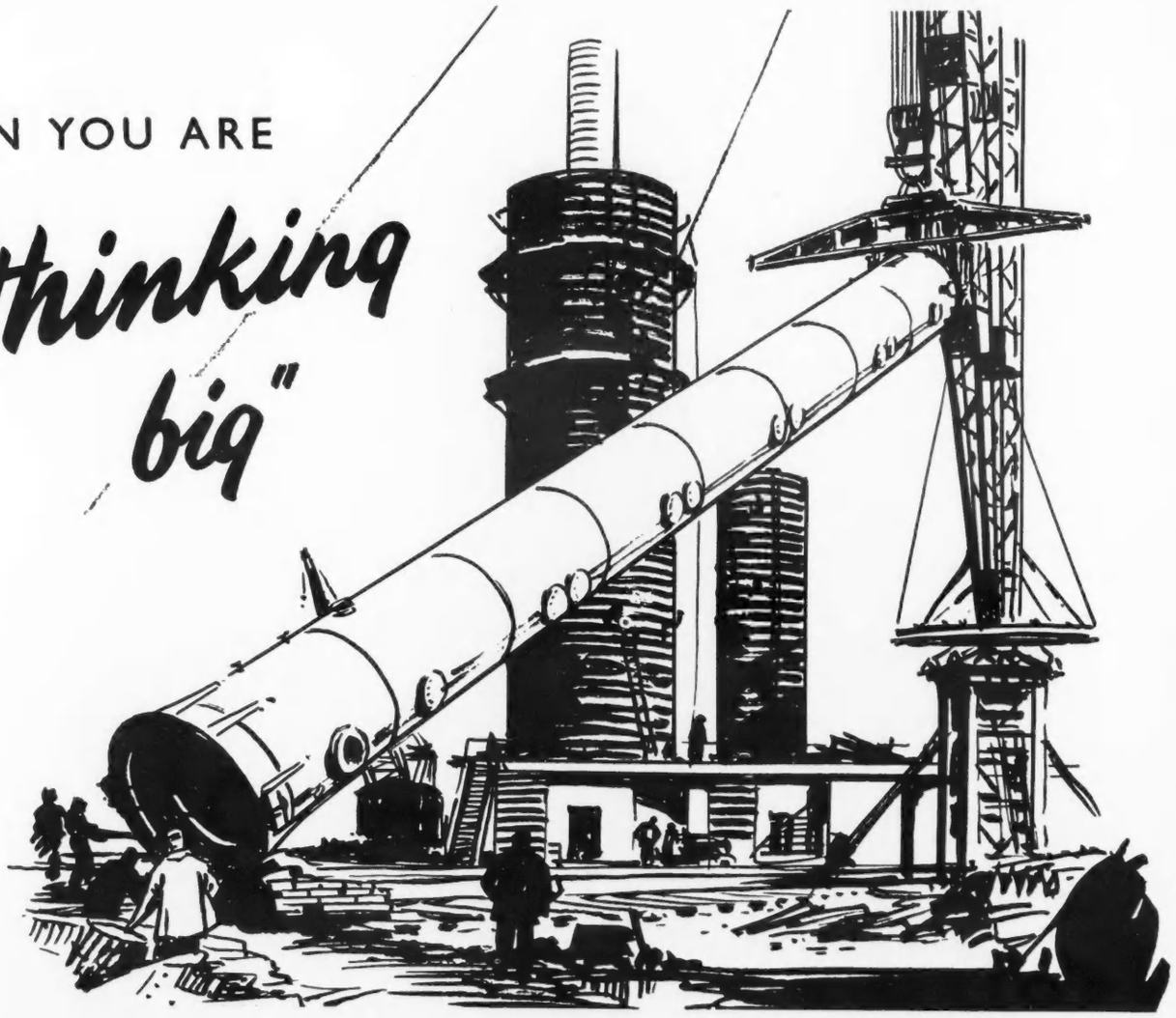
"thinking big"



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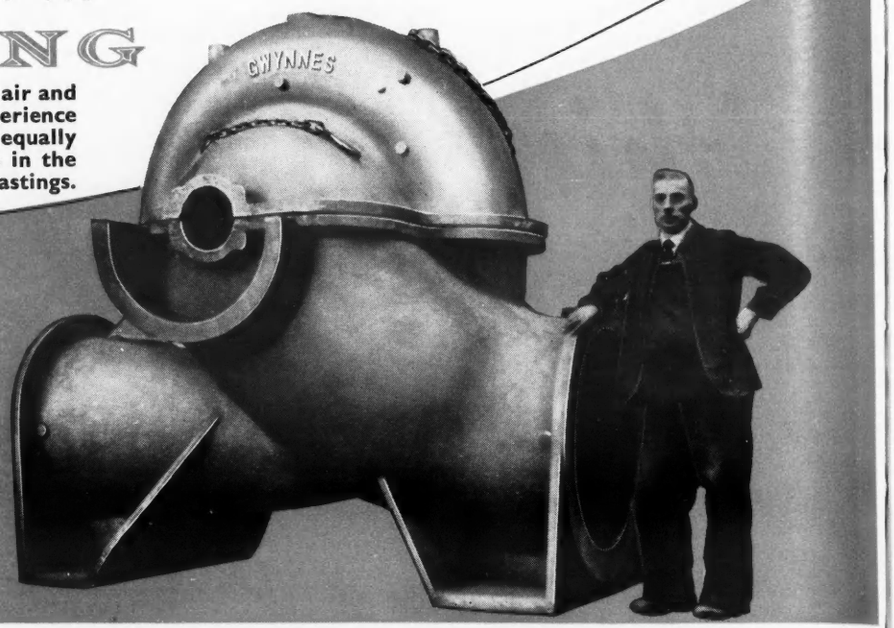
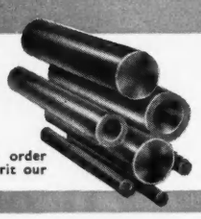


This intricate pump casting, reproduced by kind permission of Gwynnes Pumps, is cast in gun metal and weighs 7 tons 12 cwt.

We manufacture and stock large quantities of Chill Cast Solid and Cored Bars, supplied in 2" lengths or cut to customers' requirements — no order too small to merit our attention.



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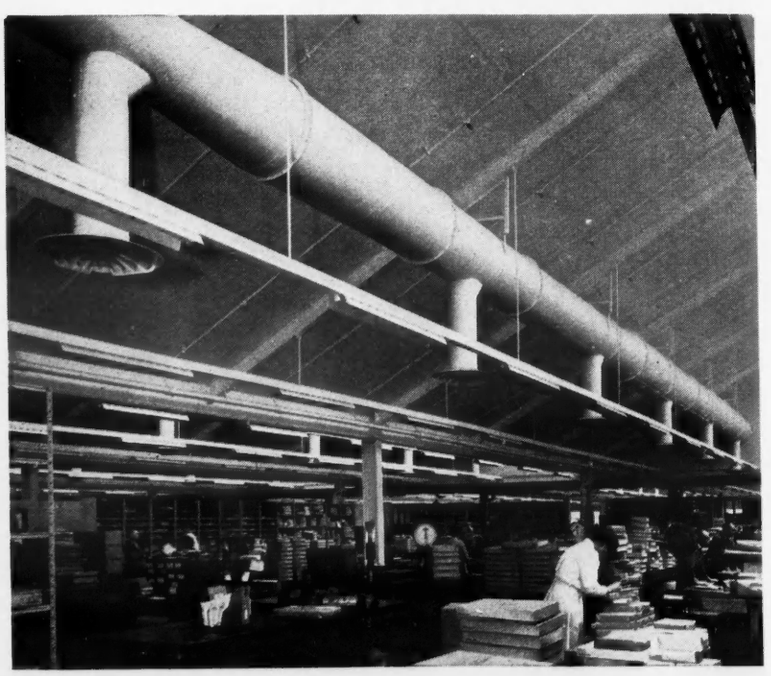

A typical Carter installation in a large printing works.

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CREATORS OF THE RIGHT AIR CONDITIONS FOR ANY PURPOSE

Ask our Engineers to advise on your particular problem

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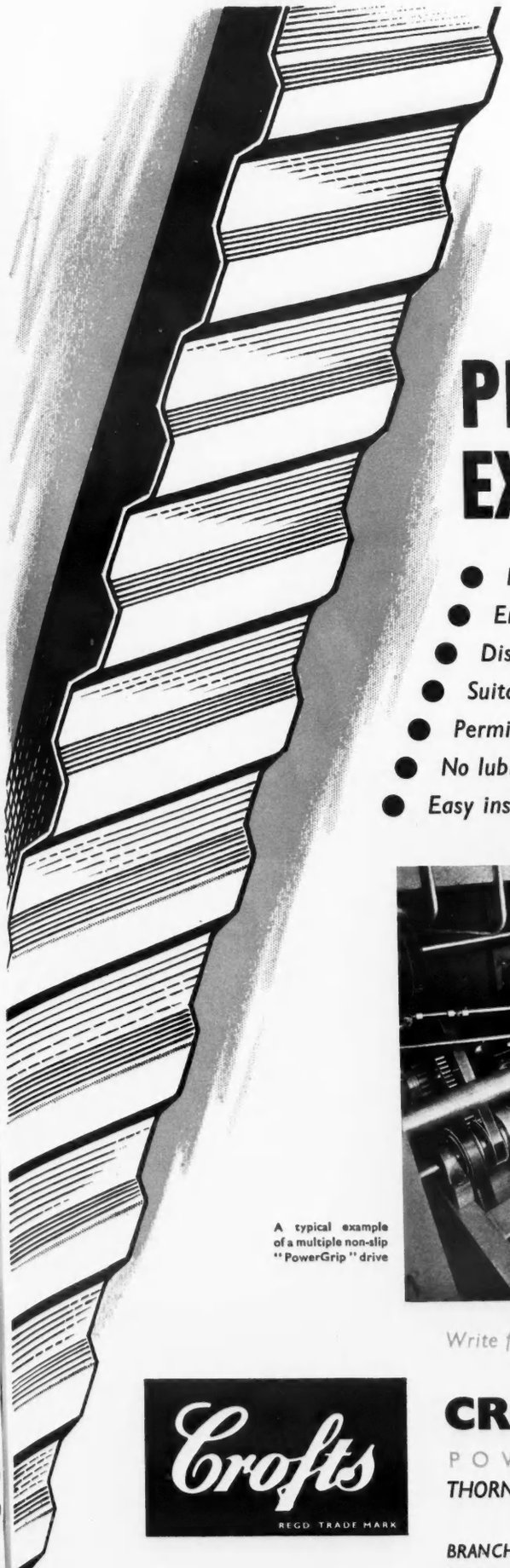

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- *Eliminate slip or power loss*
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- *Dispense with tensioning devices.*
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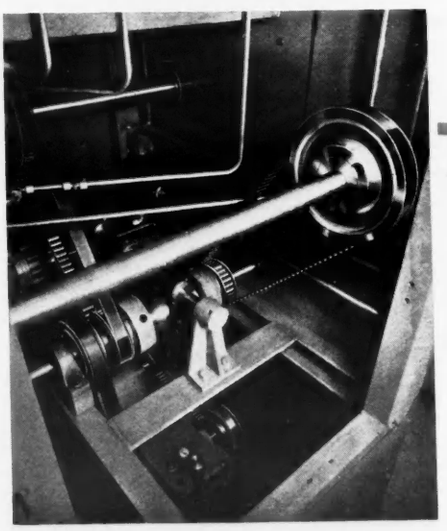
- *Easy installation with Crofts Taper-Flushbushes.*



A typical example of a multiple non-slip "PowerGrip" drive

AVAILABLE AS STOCK DRIVES —

LIGHT DUTY—$\frac{3}{8}$" PITCH
HEAVY DUTY—$\frac{1}{2}$" PITCH
UP TO 64 H.P. AT 6,000 R.P.M.
BELT WIDTHS—$\frac{3}{4}$in., 1in., $1\frac{1}{2}$in., 2in. and 3in.

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SUCCESS where other belts fail

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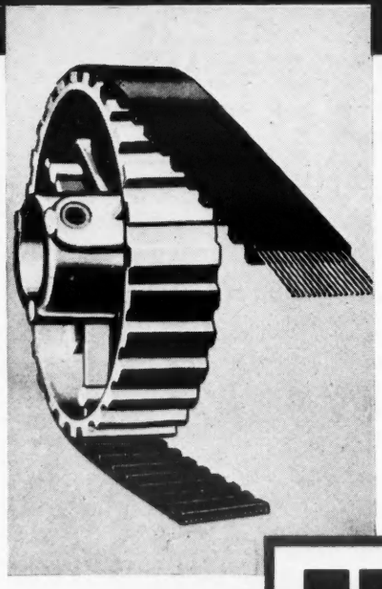

BELT DRIVES

More and more people are adopting PowerGrip as standard equipment because it provides a sure, non-slip drive at any speed, with an efficiency close to 100%. PowerGrip is compact in width and pulley diameter and, since there is no belt stretch, operation on fixed centres is possible. PowerGrip for better performance and economy without lubrication.

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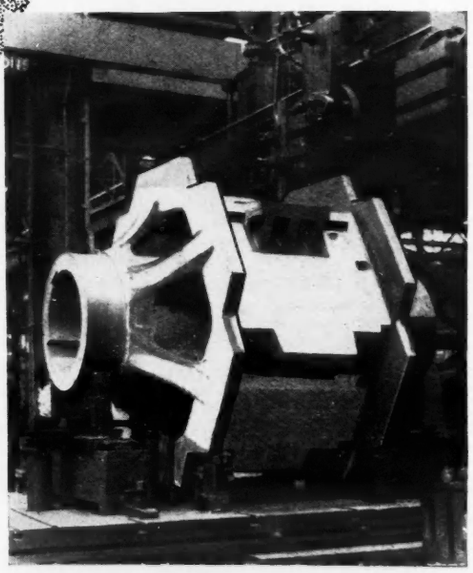

Top tumbler for tin dredging. Weight 17½ tons.

Tilting cylinder assembly. Weight 18 tons.

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to provide steam 24 hours a day. This oil firing combination saves fuel and labour and is ideal for steam cranes, pile drivers and all other types of vertical boilers.

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Caps can be supplied with coloured name or trade mark badges. Standard badges include Fuel Oil, Heater Oil, Hyd. Oil, Lub. Oil, Petrol and Water. Special badges can be supplied in reasonable quantities.

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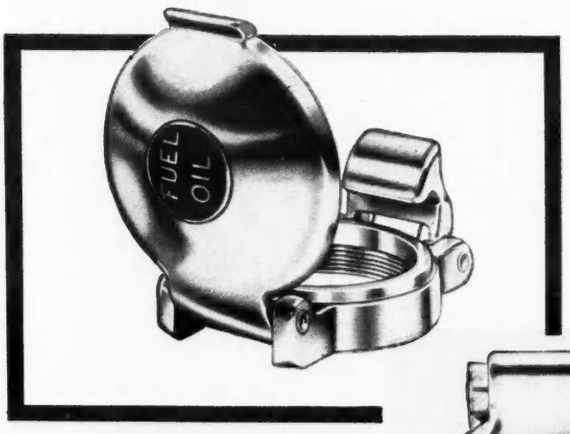

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For use with Hydraulic Fluid Tanks and incorporating a gauze breather plate inside the lid. All flange-mounted caps as illustrated below can be supplied with drop-in gauze filters if required.

An efficient, attractive and robust filler cap can improve the value of your product to your customer. Aston Filler Caps can be found fitted as standard to many commercial vehicles, diesel locomotives and some aircraft. The majority of English and many Continental racing cars also fit them. Illustrated list No. AFC. 1059 will give you further particulars — may we send you a copy?

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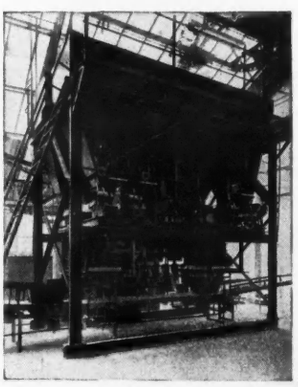

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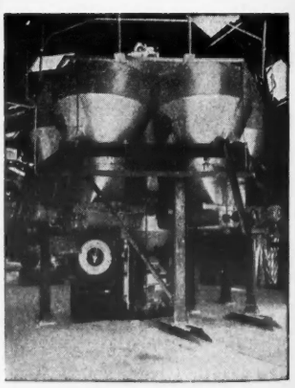

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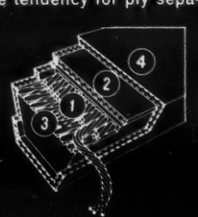

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from which is required a
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combining:
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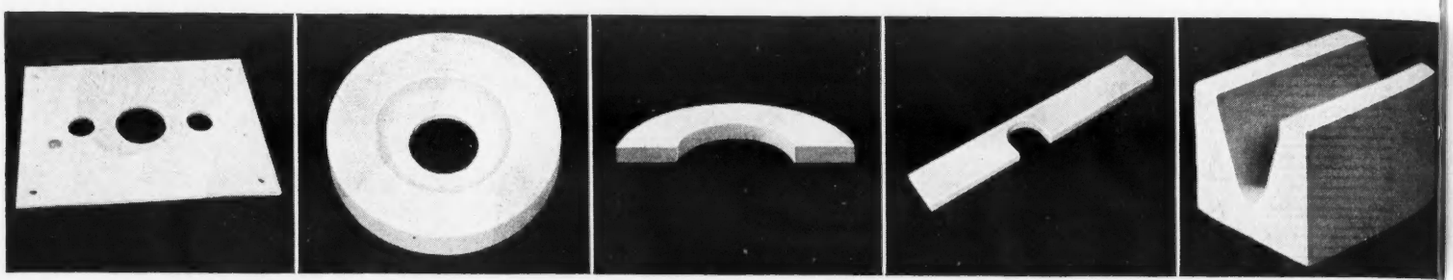

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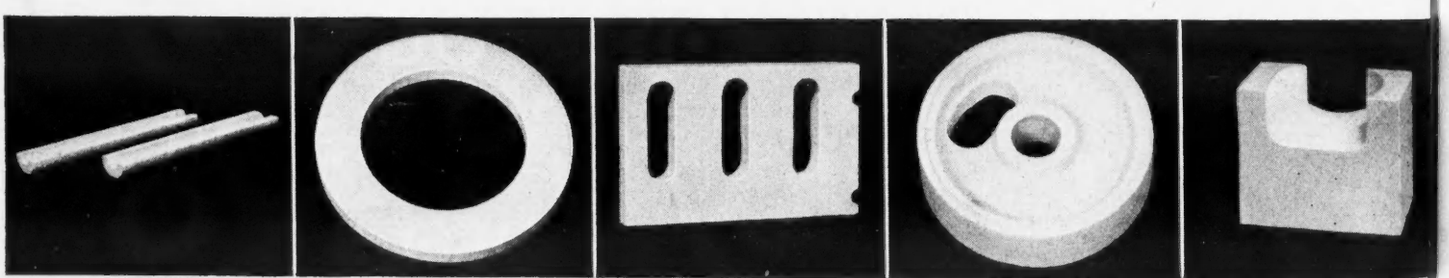

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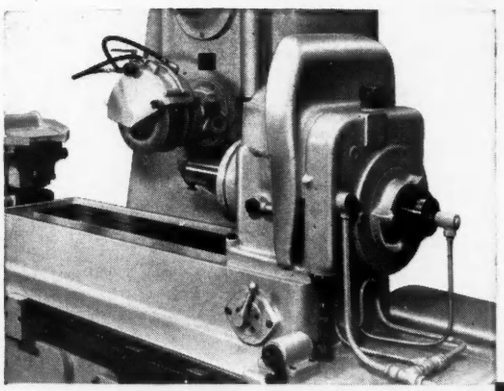

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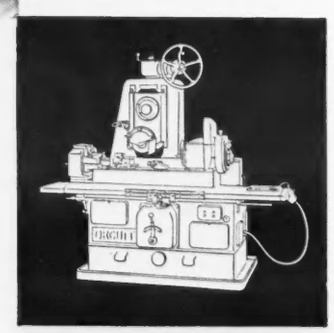

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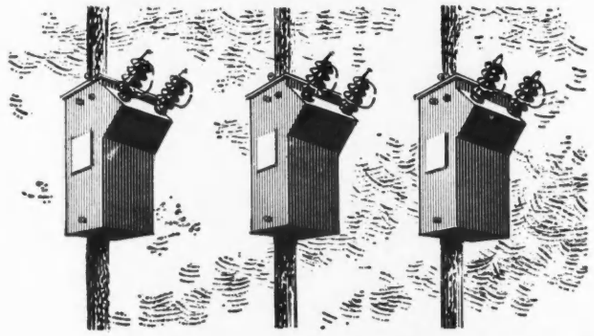
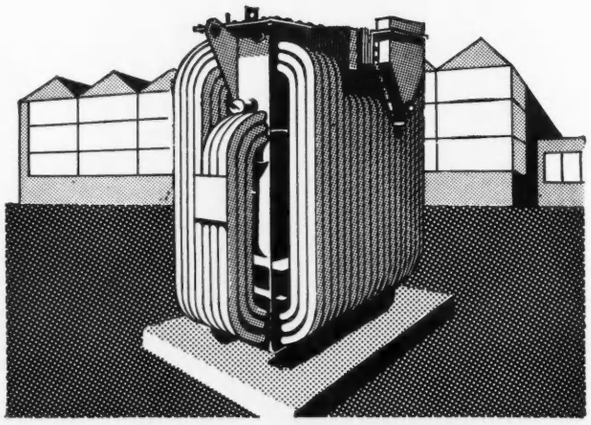
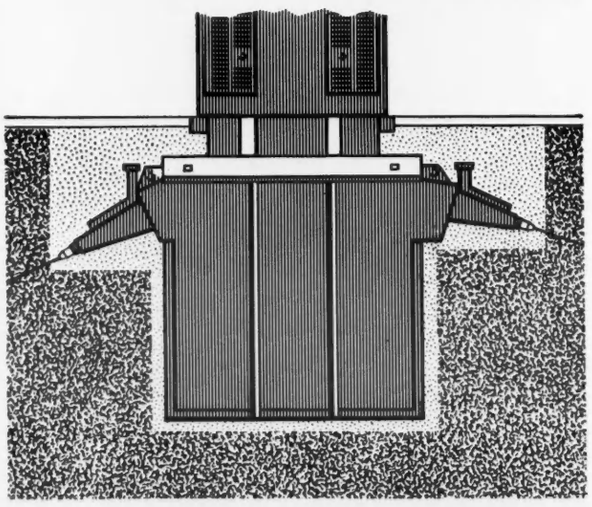


POLE-MOUNTING TYPE



SUB-STATION TYPE



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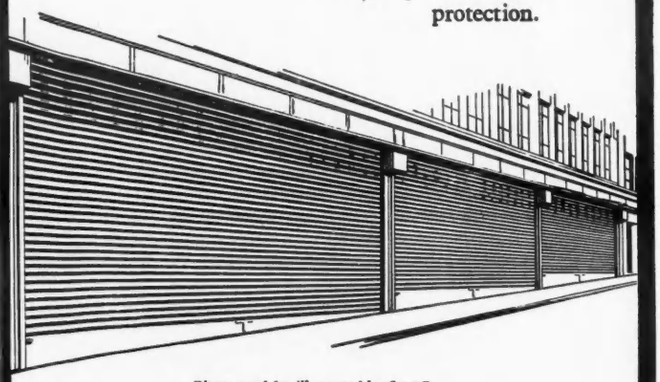

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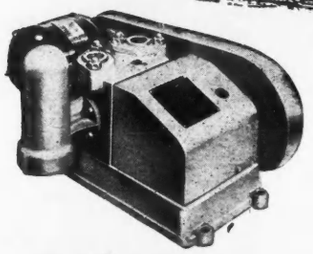

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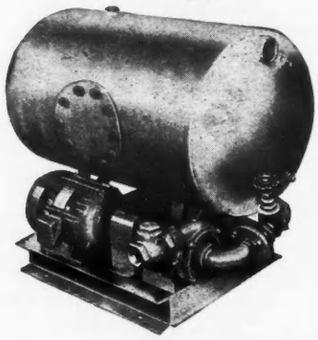
Automatic pumps designed specifically for sump drainage. Sturdy, self-contained and reliable under the most difficult conditions.



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Designed for the collection and return of condensate to the boiler house. Compact, automatically operated, these units combine a receiving tank, motor driven centrifugal pump and control gear mounted on a steel base. Tanks and pumps can be supplied for independent installation.

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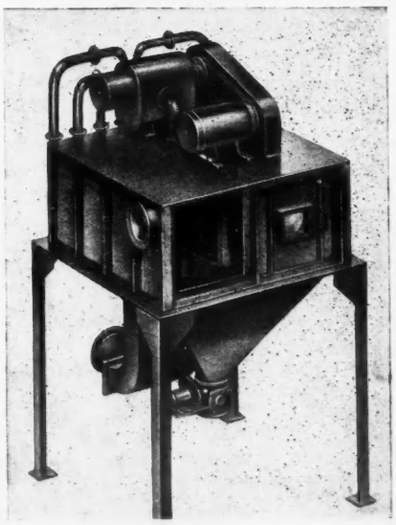

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Service for the *B.D. V-Flo Reverse Jet Dust Filter*, and the *Hermann Bauermeister Turbo Mill*, for fine and cooler grinding is cordially placed at your disposal at the BRAMIGK TEST LABORATORIES, Harwich, Essex.

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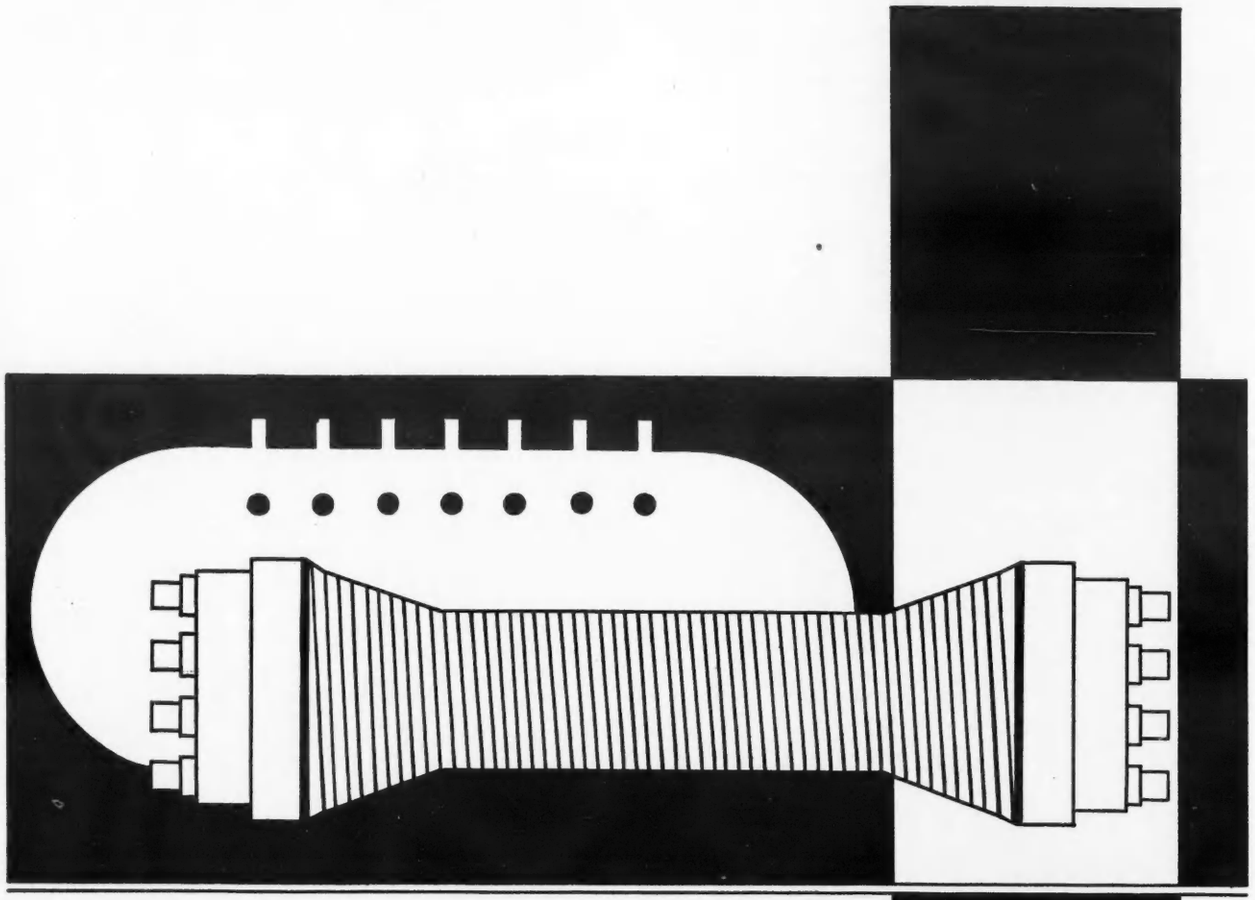

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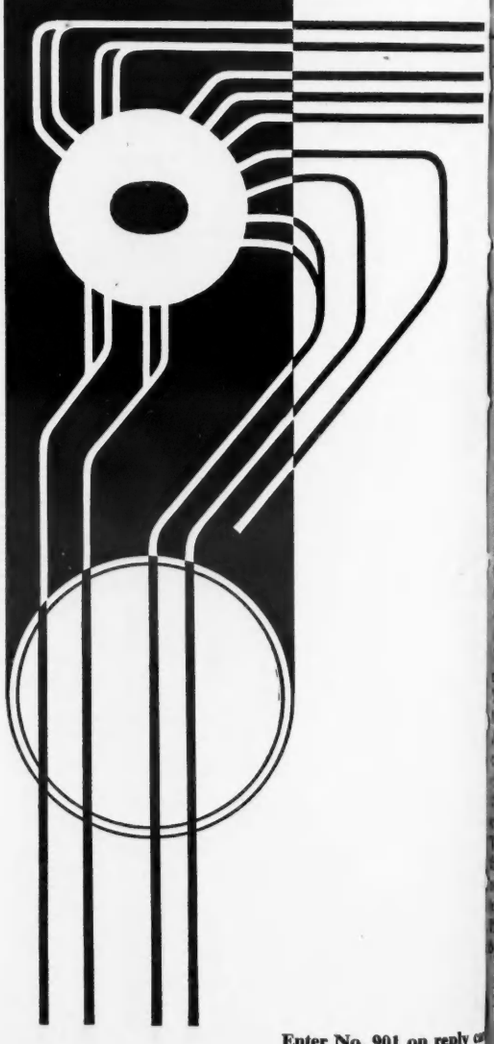

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Eliminate the risk of accidents by having your Electrical Power supplies totally enclosed in an accident proof casing and still have all the advantages of a power supply when and where you need it. The E.M.S. "TROLLEYMASTER" Enclosed Collector Track is a fool-proof system of movable power distribution and is designed to reduce the danger from trailing flexible leads and exposed conductors.

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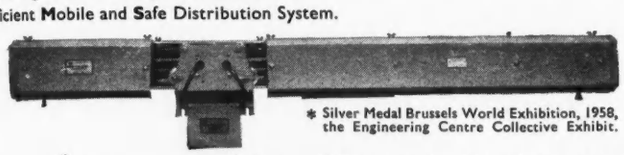
An Efficient Mobile and Safe Distribution System.



* Silver Medal Brussels World Exhibition, 1958, the Engineering Centre Collective Exhibit.

"Trolleymaster" Systems are in use by major industrial undertakings in Great Britain and Overseas. For all applications requiring a mobile power supply contact:

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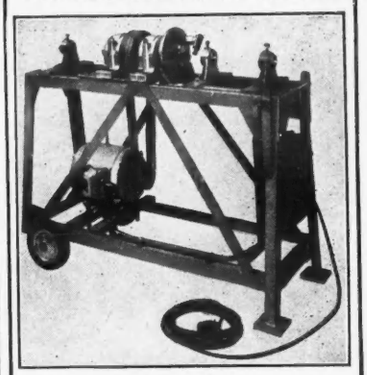

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HAVE YOU SEEN THIS?

THIS is the Rowen-Gloor jointed-arm torch cutting machine. It has four distinct working processes, which enable single or batch cuts to be carried out quickly, easily and accurately.

The Rowen-Gloor cutting head will follow a sheet metal template automatically, controlled by a magnetic roller which follows the profile of the template. The complete drive unit including the magnetic roller is adjustable vertically so that it can readily follow the inner contours of the template. The direction of rotation of the magnetic roller is reversible, enabling the shape of the template to be traced in either direction.

The Rowen-Gloor will cut direct from a drawing by a simple manual control. The tracing pin enables a drawing to be followed, by hand, to within close limits. A built-in device enables a 90° change of direction to produce accurate square corners.

The Rowen-Gloor will make straight cuts in any direction automatically. The parallel guide arrangement ensures that the wheel continues to run in a preset direction enabling long, straight cuts to be made.

The Rowen-Gloor will cut accurate circles by use of a compass beam. Here too the feed is governed by the wheel—but with a compass beam attached to the wheel head. The diameter of the workpiece can be set direct on the scale engraved on the compass beam. The pivot of the beam is held in position on the metal guide table by a magnet—which means the centre can be seated anywhere on the guide table.

The Rowen-Gloor is a sturdy, simple to operate machine which will produce precision cuts at high speed in mild steel from ⅛" to 4½" thick.

It does not need a special foundation and is protected against vibration. With its almost negligible maintenance costs and its astonishingly low initial price, the Rowen-Gloor is a unique machine.

ROWEN-GLOOR JOINTED-ARM FLAMECUTTING MACHINE

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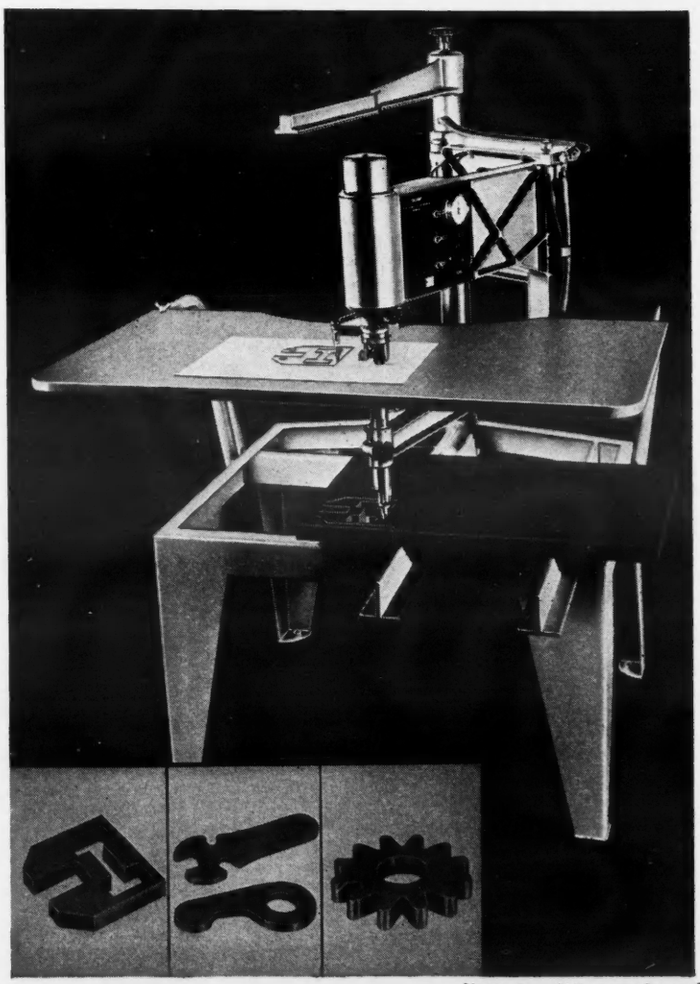

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ISSUED BY THE NATIONAL COAL B

COAL

OOD REASONS

t sunshine and golden grain, harvested at peak of perfection—that's Kellogg's, the me that has brightened the breakfast tables scores of millions of homes on both sides of Atlantic.

e men who have so successfully changed the id eating habits of nations are demonstrably n of both vision and sound judgment—two alities which guide and control every long- m decision they make. Take fuel, for ex- ple. When the choice of fuels was examined, llogg's voted for coal. Why? Because— ong many other good reasons—they knew t coal provides all the steam power they d at the lowest cost; because coal—mech- cally stoked—is smokeless; and because itish coalfields can supply all the coal that dustry will need both now and in the foresee- e future.

en the time comes for you to make a decis- on fuel, remember Kellogg's. Coal has ped them to create a mouth-watering suc- . It could well heap your own plate with same golden sunshine.

PROGRESSIVE INDUSTRY IS GOING FORWARD ON

COAL

Coal into energy at Kellogg's Stretford Factory

Mr. E. Tomlinson,

Plant Engineer, comments:

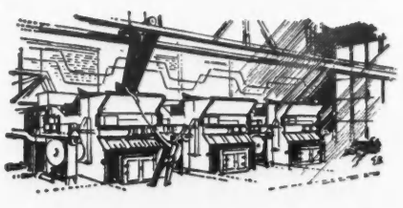
"Our processing plant operates continuously every week from Sunday night until Saturday morning, with an average load of 45,000 lbs. an hour, and intermittent peaks of up to 50,000 lbs. an hour. We have three water tube boilers, all operating on coal. Normal operation is with the largest boiler, fitted with an economiser, which maintains an efficiency of 83%, and one small boiler, without economiser, with an efficiency of 71%. The other small boiler is maintained as a stand-by; this is completely filled with treated water to prohibit corrosion and is available for immediate firing.

The original installation at Stretford was completed in 1937 when two water tube boilers were installed, both fired by chain grate stokers. Each boiler was designed to generate 17,000 lbs. of steam per hour, which was sufficient for operation of the plant.

In 1946 began a period of expansion and very soon both boilers were steaming continuously to provide sufficient steam for processing the growing output of various breakfast cereals. In 1950 a further water tube boiler was installed and, guided by the trouble-free service of the other two boilers, this unit was also fitted with a chain grate stoker for coal firing. Anticipating the Clean Air Act, we arranged to have grit arresters fitted to the new boiler and the two original boilers. Such was the growing demand for steam that the largest boiler was supplying steam to process before the official commissioning trials had taken place. This boiler was rated at 40,000 lbs. per hour and has been in continuous operation ever since, being shut down only for our annual holiday period when it is thoroughly cleaned and inspected.

We expanded again in 1954 and when further modernisation plans were considered we found that the two original boilers could be rebuilt to meet modern demands. Today all three boilers continue to give us a first-class service.

Our decision to burn coal is based on the extreme reliability of the coal handling and firing equipment, together with the economic fuel cost."



Here are some key facts and figures about the consumption of coal at Kellogg's:

Boilers:	3 water tube
Method of firing:	chain grate stokers
Boiler efficiency:	80%
Max. steam rating:	74,000 lbs/hr
Steam pressure:	165 p.s.i.
Steam temperature:	375°F
Annual fuel consumption:	13,500 tons of coal

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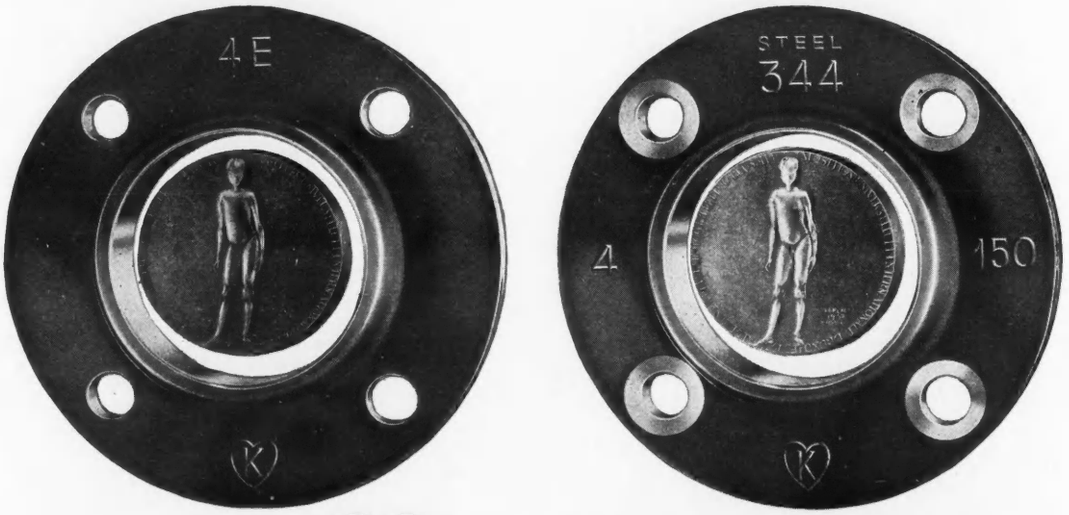

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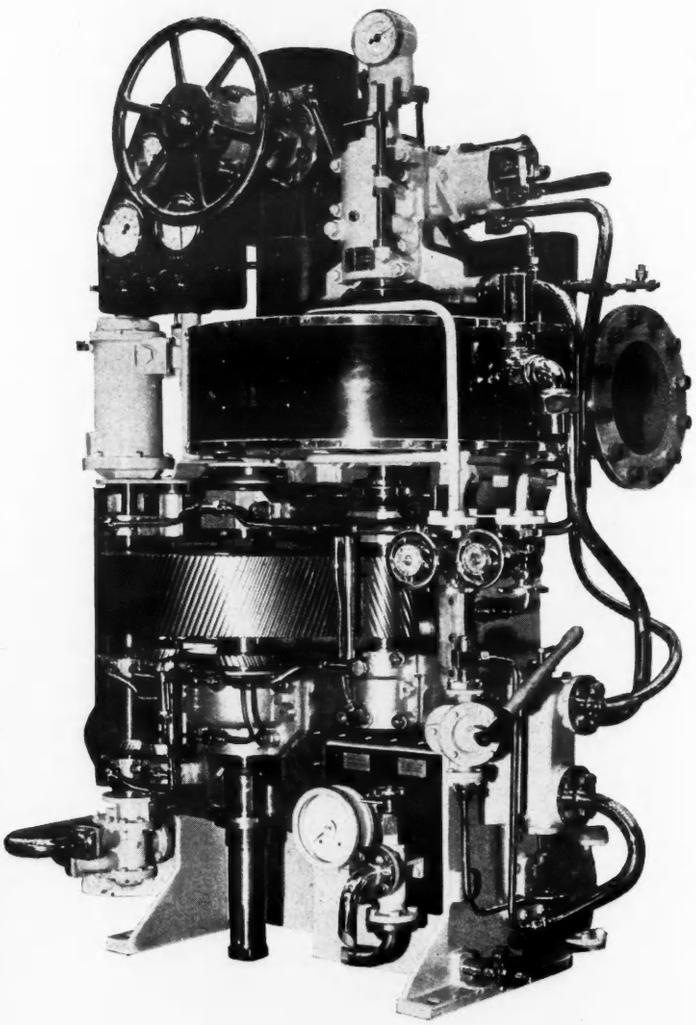

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Fixed or Variable Speeds (Geared or Direct Drive)

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Weir Steam Turbines are available in Standard designs up to 1,000 B.H.P. and Special designs up to 2,500 B.H.P., and shaft speeds from 500 to 16,000 r.p.m.
The ideal prime mover for forced and induced draught fans, boiler feed pumps, cargo oil pumps, circulating pumps, and other auxiliary machinery.

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CLASSIFIED ADVERTISEMENTS

PUBLIC APPOINTMENTS · SITUATIONS VACANT · TENDERS · EDUCATIONAL · BUSINESSES and PREMISES · BUSINESS OPPORTUNITIES PATENTS · MISCELLANEOUS · AGENCIES · DIRECTORS · PARTNERSHIPS

Lineage Rate. 4/6 per line of approximately 6 words. Minimum 18/-. **Inch Rate.** 54/- per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £29 10s. ½-page £54. Full page £100.

FOR SALE · MACHINERY, etc., WANTED · AUCTION SALES · SITUATIONS WANTED · SUB-CONTRACTING · DESIGN SERVICES · FOR HIRE

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-. **Inch Rate.** 48/- per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C.2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

KUMASI COLLEGE OF TECHNOLOGY

GHANA

DEPARTMENT OF ELECTRICAL ENGINEERING

TECHNICAL INSTRUCTORS

Applications are invited for two posts of TECHNICAL INSTRUCTORS in the Department of Electrical Engineering.

Applicants must have had a sound technical eduation and should possess either the Higher National Certificate or Diploma. Some experience in Technical College work will be an advantage.

Successful candidates will take full-time classes in a 4-year diploma course in Electrical Engineering, prepare and supervise laboratory work in Electrical Power, Machines and Measurements and assist in laboratory development and research work.

The Contract Salary Scale is £1295 by £56 to £1855.

In addition children's allowances are paid up to a maximum of three, and a gratuity at the end of the contract at the rate of £150 for each year of satisfactory service. The entry point is fixed according to qualifications and experience.

The College is fully residential, and members of staff are housed in pleasant modern bungalows on the spacious campus ; climate and living conditions are good.

Annual leave with three free return passages in four years is granted to members of staff and their families.

Application forms and an Information Brochure may be obtained from the Assistant Registrar, Kumasi College of Technology, 29 Tavistock Square, London, W.C.1, who will also be glad to answer any questions about this appointment. The closing date for applications is mid-August. E5615

QUEEN MARY COLLEGE

(UNIVERSITY OF LONDON)

LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING

Applications are invited for the post of LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING. Applicants should have had at least two years of Civil Engineering practice. Experience in teaching and research will be an advantage. Tenable 1st October 1960. Salary scale £1050 by £50 to £1400 by £75 to £1550 (efficiency bar): by £75 to £1850, plus London Allowance £60, F.S.S.U. participation and family allowance of £50 for each child. Application forms, obtainable from the Registrar, Queen Mary College, Mile End Road, E.1., to be returned by August 22nd. E5626

CITY OF CARDIFF CORPORATION WATERWORKS

APPOINTMENTS OF ENGINEERING ASSISTANTS

Applications are invited for the following permanent appointments :

(a) MECHANICAL ENGINEERING ASSISTANT, Grade APT.IV, £1065 to £1220 per annum.

(b) JUNIOR ENGINEERING ASSISTANT, Grade APT.II, £765 to £880 per annum.

Candidates for post (a) must be Associate Members of the Institution of Mechanical Engineers. Preference will be given to candidates who have had experience of pumping installations.

Candidates for post (b) must have completed professional training and have passed Parts "A" and "B" of the examination of the Institution of Civil Engineers, or possess a University Degree in Civil Engineering.

General Conditions of Appointment can be obtained from the Water Engineer and Manager, Municipal Buildings, Greyfriars Road, Cardiff, and applications, stating age, previous experience and qualifications, together with the names of two referees, should reach the undersigned, in envelopes appropriately endorsed, on or before Tuesday, 30th August, 1960.

S. TAPPER-JONES,
Town Clerk.

City Hall,
Cardiff.
July, 1960. E5578

PUBLIC APPOINTMENTS

BOROUGH OF BANBURY

APPOINTMENT OF RESIDENT ENGINEER

Applications are invited for the appointment of a RESIDENT ENGINEER to supervise the construction of a Sewage Pumping Station, approximately 1900 linear yards of gravity sewers from 24in. dia. to 12in. dia. and 1100 linear yards of 14in. dia. asbestos cement rising main which will be the subject of one Contract followed by extensions to the existing sewage treatment works which will be the subject of a separate Contract.

The work will be executed under the direction of the Council's Consulting Engineers, Messrs. J. D. and D. M. Watson, M.I.C.E., 67, Tufton Street, Westminster, London, S.W.1. Work will commence with Contract No. 3 which is due to start in October and it is expected that Contract No. 4 will commence before the first Contract is completed. The salary offered is £1250 per annum, such salary to be adjusted according to any national increases and the appointment, subject to satisfactory service will last approximately two years, terminable by two months notice in writing on either side. No housing accommodation will be made available for this appointment.

The person appointed will, if he has his own car be paid an essential user car allowance on the basis of a car not exceeding 10 h.p.

Applicants should preferably be Corporate Members of the Institution of Civil Engineers, and should have had experience of similar work ; they should apply in writing to the undersigned not later than 22nd August giving full particulars of age, qualifications and experience, together with the names and addresses of two referees.

FREDERICK G. BOYS
Town Clerk.

Municipal Buildings,
Banbury, Oxon. E5550

CITY OF BIRMINGHAM SALVAGE DEPARTMENT

APPOINTMENT OF DEPUTY CHIEF ENGINEER

Applications are invited for the post of DEPUTY CHIEF ENGINEER in the above Department at a salary within the range £1220 to £1375.

Candidates must be Corporate Members of the Institution of Mechanical Engineers, and the person appointed will be responsible for the installation and maintenance of the mechanical and electrical plant at the various Refuse Disposal and Salvage Works of the Department.

Full details of the appointment may be obtained from the undersigned, to whom completed applications must be delivered not later than MONDAY, 12th SEPTEMBER, 1960.

ALAN E. BARTON,
General Manager.

Civic Centre,
Broad Street,
Birmingham, 1. E5592

CITY OF LIVERPOOL

CITY ENGINEER AND SURVEYOR'S DEPARTMENT

ASSISTANT CITY ENGINEER (MECHANICAL)

Applications are invited for the appointment of : ASSISTANT CITY ENGINEER (MECHANICAL). Salary : £1655 to £2085 per annum (J.N.C. Scales E/F).

Applicants should be Associate Members of the Institution of Mechanical Engineers and have had a good general engineering background, together with experience of works organisation and management. The person appointed will be responsible for the organisation and control of the mechanical engineering drawing office and central engineering workshops and for maintaining a large fleet of vehicles, civil engineering plant, sewage pumps and other mechanical equipment.

The appointment is superannuable and subject to the Standing Orders of the City Council. Canvassing disqualifies.

Further details and application forms, returnable by 3rd September, 1960, obtainable from the City Engineer and Surveyor, Municipal Buildings, Liverpool, 2.

THOMAS ALKER,
Town Clerk.

(J6325) E5602

PUBLIC APPOINTMENTS

METROPOLITAN WATER, SEWERAGE AND DRAINAGE BOARD OF NEW SOUTH WALES

AUSTRALIA

ENGINEERS

Applications are invited from graduates or diplomates (preferably under 30 years of age) in Engineering for appointment to the Engineering staff of the Metropolitan Water, Sewerage and Drainage Board of New South Wales. Because of accommodation difficulties, vacancies exist only for single men and married men without children.

Minimum commencing salary £A1242 p.a. for a diplomate and £A1360 for a graduate, with incremental progression, subject to satisfactory service, to £A2002 p.a. Progression beyond this rate is by appointment as vacancies arise.

The main requirement is for Civil Engineers, who have just completed training, but consideration will also be given to those with some experience and to graduates and diplomates in Mechanical, Electrical and Chemical Engineering.

Superannuation Scheme. Good leave conditions.

Successful applicants will be nominated for travel under the Assisted Passage Scheme. The cost of the passage is £10 per adult.

For further particulars and application forms, please write to Agent General for New South Wales, 56 Strand, London, W.C.2. E5597

MID-NORTHAMPTONSHIRE WATER BOARD

DEPUTY ENGINEER AND MANAGER

The Board invite applications for the post of DEPUTY ENGINEER & MANAGER.

Applicants must be corporate members of the Institution of Water Engineers, and have had several years of experience, with responsibility, in waterworks.

The commencing salary is £1770, rising by £70 p.a. to £2050. A house is available, and a car allowance will be paid.

The appointment is subject to the Superannuation Acts.

Applications, accompanied by the names of three persons to whom reference may be made, should be sent to me not later than 14th September.

LEONARD H. BROWN,
Engineer and Manager.

Cliftonville,
Northampton. E5588

MINISTRY OF AVIATION

FARNBOROUGH

TECHNICIAN

Ministry of Aviation require TECHNICIAN at Farnborough, Hants to supervise the maintenance and overhaul of machine tools, wind tunnels and ancillary equipment, mechanical test rigs, lifting equipment, &c. Qualifications recognised engineering apprenticeship. O.N.C., appropriate City and Guilds Final Certificates or equivalent. Extensive experience of maintenance and fault investigation of a wide variety of plant. Comprehensive knowledge of the Factories Act relating in particular to lifting equipment is essential. General knowledge of motor transport, lifting appliances and heavy plant handling an advantage. Salary. £850 (age 30) to £1005. Applications forms from Manager (P.E.2431), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4. E5621

MANCHESTER COPORATION TRANSPORT DEPARTMENT

CHIEF TECHNICAL OFFICER

Qualified engineer required to supervise section dealing with general technical investigation and experimental duties associated with public service vehicle operation and maintenance. Salary in accordance with J.N.C. scale 'B' (£1260 to £1485 P.A.)

Forms and details from Town Clerk, Town Hall, Manchester, 2, returnable by 12th September, 1960. E5627

PUBLIC APPOINTMENTS

NEW SOUTH WALES PUBLIC SERVICE

AUSTRALIA

ENGINEERS AND ARCHITECTS

Qualifications : Appropriate Degree, Diploma or Institute membership (by examination).

Salary : From £A1359 to £A2069. Commencing rate according to qualifications and experience. Promotion positions carry salaries up to £A2800 and beyond.

Experience : Civil, Mechanical and Electrical engineering or architectural design and supervision. Applicants will be employed in the New South Wales Department of Public Works on a wide range of engineering and architectural projects including dam, water supply, sewerage, road and bridge construction, building services and in the construction of schools, hospitals and other public buildings.

Subject to satisfactory medical report the successful applicant and family under the age of 19 years will be nominated to travel under the Assisted Passage Scheme to New South Wales.

Further details and copies of application forms obtainable from Agent General for New South Wales, 56-57, Strand, London, W.C.2. Applications close on 31st August, 1960. E5596

WAR OFFICE

RESEARCH AND DEVELOPMENT ESTABLISHMENTS

APPOINTMENTS

CHEMISTS, MATHEMATICIANS (including STATISTICIANS), METALLURGISTS, MECHANICAL and ELECTRICAL ENGINEERS, AND PHYSICISTS (including BIOPHYSICISTS) (men and women) required for Research and Development Establishments of War Office at various locations including Sevenoaks, Kent ; Byfleet, Chertsey and Tolworth, Surrey ; Shoeburyness, Essex ; Christchurch and Farnborough, Hants ; Salisbury, Wilts ; Cornwall. Appointments in grades of (a) SENIOR SCIENTIFIC OFFICER, £1250 to £1540, or (b) S.O. £690 to £1145. Starting salary according to experience. (Women's rates the same by 1961.) Superannuation under F.S.S.U. with opportunities for candidates under 31 to compete for established (pensionable) posts. 1st or 2nd Class Hons. degree or equivalent required, and for (a) minimum age 27 and at least 3 years post-graduate research experience. Forms from Technical and Scientific Register (K), Ministry of Labour, 26, King Street, London, S.W.1, quoting A.300/OA. E5610

WOLVERHAMPTON CORPORATION WATER UNDERTAKING

TWO ENGINEERING ASSISTANTS

Wolverhampton Corporation Water Undertaking requires TWO ENGINEERING ASSISTANTS for new works design and construction. Salary according to qualifications and experience, £1065 to £1220 (Grade APT IV) or £785 to £1070 (Special Grade). N.J.C. Service Conditions, 5-day week, house to rent. Post pensionable, medical examination. Applications, naming two referees, to Water Engineer and Manager, Water Offices, 37 Merridale Road, Wolverhampton, by August 29th 1960. E5623

METROPOLITAN BOROUGH OF BATTERSEA

RESIDENT BATHS ENGINEER

RESIDENT BATHS ENGINEER required. A.P.T. Grade I (£610 to £765) plus £40 London weighting and residence. Particulars and application form which must be returned by the 30th August, 1960, can be obtained from the Town Clerk, Town Hall, Battersea, S.W.11. E5619

TENDERS

KINGDOM OF THAILAND

ROYAL IRRIGATION DEPARTMENT, BANGKOK, THAILAND

INVITATION FOR BIDS—NO. YS-4-8

The Royal Irrigation Department of the Kingdom of Thailand hereby invites SEALED WRITTEN BIDS for FURNISHING and DELIVERING the following GOODS and MATERIALS either f.o.b. Contractor's shipping point, or c.i.f. Bangkok Wharf, Thailand, for the Bhumipol Power Plant, Yanhee Multipurpose Project, Kingdom of Thailand, in accordance with the Contract Documents, for :

Furnishing One (1) lot, Structural Steel for Powerhouse Roof ; One (1) Structural Steel End Wall, complete with Corrugated Asbestos Sheet Siding and Fasteners ; and Three (3) Structural Steel and Aluminium Hatch Covers and Frames.

Invitations for Bids will be issued in August, 1960, and will be opened in October, 1960. Copies of Contract Documents, Invitation for Bids—No. YS-4-9, may be obtained by qualified Bidders on written request to : Royal Irrigation Department, Attention : Thai Liaison Engineer, c/o Engineering Consultants, Inc., 1901 South Navajo Street, Denver 23, Colorado.

Each request must be accompanied by a cheque or money order, payable to the Royal Irrigation Department, in the amount of U.S. $10.00 for each copy of the Contract Documents requested. The remittance is non-returnable.

M. L. XUJATI KAMBHU,
Director General.

Royal Irrigation Department,
Kingdom of Thailand,
Bangkok, Thailand. E5618

CITY OF CARDIFF

CORPORATION WATERWORKS

LLANDEGFEDD WATER SCHEME

TENDERS will shortly be invited from suitable contractors for the CONSTRUCTION of the Llandegfedd Impounding Reservoir and ancillary works, the main feature being an earthen embankment 120ft. high and 1150ft. long.

Contractors who wish to be considered for inclusion in a selected list of Tenderers should apply to the Corporation's Consulting Engineers, Messrs. Rofe & Raffety, 9, Brewer's Green, London, S.W.1, before 22nd August, 1960, giving details of their experience on similar projects.

S. TAPPER-JONES,
Town Clerk.

City Hall,
Cardiff. E5609

INDIA STORE DEPARTMENT

TENDER REF. NO. 16052/60/BMB/HAL

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :

TENDER REF. No. 16052/60/BMB/HAL
UNIVERSAL DIAL TYPE MILLING MACHINE, table working surface 79½in. by 16½in., range 42in. by 14in. by 19in.—1 off.

The Tender forms with Schedule and Specifications which are returnable on 5th September, 1960, may be obtained from the above Office (Co-Ordination Branch) on payment of a fee of 10s. (not refundable) for each Tender.

Please quote the above reference number. E5613

INDIA STORE DEPARTMENT

TENDER REF. NO. 16058/60/BMB/HAL

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :

TENDER REF. No. 16058/60/BMB/HAL
SINGLE SPINDLE TYPE PLANO COPY-MILLING MACHINE, working area of table, 48in. by 120in., hydraulic copying attachment.

The Tender forms with Schedule and Specifications which are returnable on 5th September, 1960, may be obtained from the above Office (Co-Ordination Branch) on payment of a fee of 10s. (not refundable) for each Tender.

Please quote the above reference number. E5614

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, London, W.3, invites TENDERS for the SUPPLY of :

PAPER MILL MACHINES, including Chipper, Diffuser, Filter, Stuff Pump, Pulp Screen, Duplex Cutter, Reeler, &c.

Forms of Tender which are returnable on Thursday, 8th September, 1960, may be obtained from this Office (CDN Branch), upon payment of a fee of 10s. 9d., which is not returnable. Reference No. 302/60.CDN must be quoted in all applications. E5625

EDUCATIONAL

A.M.I.MECH.E., B.SC., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 90 per cent. successes. 148-page, prospectus, free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. B114 E

EDUCATIONAL

PLYMOUTH AND DEVONPORT TECHNICAL COLLEGE

TAVISTOCK ROAD, PLYMOUTH

(Principal : E. BAILEY, B.Sc., F.R.I.C., A.M.I.Chem.E.)

FULL TIME ENGINEERING COURSES
SESSION 1960–61

B.Sc. (Engineering) London External (Mechanical, Civil, Electrical).
H.N. Diploma (Mechanical ; Electrical (to revised I.E.E. requirements).
College Diploma in Civil Engineering.
P.M.G. Certificates (Radio Officers/Operators).
M.O.T. Radar Maintenance Certificate.
For full particulars apply to the College Registrar.
Clerk to the Governors.
E5591 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A PROJECT ENGINEER is required for development work in the paper converting industry.

The work is varied and the person appointed will be concerned in all stages of mechanical development, from initial design to installation.

The successful applicant will have an adaptable mind, will possess H.N.C. (mechanical) and will have experience along similar lines, though not necessarily in the field of paper conversion.

Applications giving full particulars of experience and present salary should be addressed to BOX No. E5598, " The Engineer." A

A YOUNG ENGINEER with H.N.C. or equivalent for original work on hydraulic presses and cold flow forging. Congenial working conditions ; Charlton district.—BOX No. E2967, " The Engineer.' A

APPLICANTS ARE INVITED for a post as ASSISTANT DESIGNER for work on Steam Turbines, Centrifugal Blowers and Compressors and allied equipment. Applicants should be about 25 years of age and possess University Degree, H.N.C., or equivalent in Mechanical Engineering, and should preferably have had some practical experience. Salary according to qualifications and experience. —Write, giving full particulars, to D. Adamson & Co. Engineers, Dukinfield, Cheshire. E5565 A

ASSISTANT ENGINEERS with mechanical or electrical training required for Head Office in London. The work involves negotiation of contracts with suppliers of a wide range of processing machinery and fixed plant. Occasional travel may be involved in U.K. and abroad. Preferred age 24-27 years and candidates should have qualifications leading to Corporate Membership of an Engineering Institution. Pension fund and free lunch facilities. —Apply to Personnel Department, British-American Tobacco Company Ltd., 7 Millbank, London, S.W.1. E5617 A

DESIGNER DRAUGHTSMAN

required by the National Coal Board in London (Victoria Area). Applicants should have received a sound technical education and be experienced in the design of mining mechanical equipment or similar equipment to that used in the mining industry. The possession of a H.N.C. or equivalent qualification is desirable.

Appointment superannuable : salary according to qualifications and experience within £853—£990.—Write for application form to Staff Department (X.1901/2C) N.C.B. Hobart House, London, S.W.1. before 22nd August, 1960. E5604 A

DRAUGHTSMEN required with Mechanical Handling experience in the bulk field, Conveyors, Elevators, Structural Steelwork, &c. Experience in Layout and Design would be an advantage. Modern offices, luncheon vouchers.—Apply W. W. Brown & Partners Ltd., Haddon House, Fitzroy Street, London, W.1. E2968 A

EDWARD A. PITCHER & PARTNERS require experienced R.C. Designer/Draughtsmen. Commencing salary £1150 p.a. Progressive positions with interesting projects. 5-day week. Luncheon Vouchers.—Apply : 14 Queenhithe, E.C.4. E5529 A

ENGINEER for Inspection of Cranes and Lifting Plant required. Must have drawing office experience of design of Cranes also National Certificate in Mechanical Engineering. Areas Essex and Liverpool. Starting salary £800 rising to £1100—other benefits—permanent.—Write Box ER 720 LPE Romano House, 399/401 Strand, London, W.C.2. E5601 A

ENGINEER to take charge of site investigations and soil mechanics laboratory required by Consulting Engineers in Westminster. Excellent opportunity for well qualified, energetic man to secure pensionable post.—BOX No. E5586, " The Engineer." A

ENGINEERS, DRAUGHTSMEN, and all Technical staff, are invited to forward details of qualifications, etc., to Abbatt Technical Division, who will handle and negotiate on their behalf, without charge, any change of employment contemplated. Leading Organisations consult Abbatt, 25, Kensington High Street, W.8. WES. 0768-9. E2962 A

ENGINEER SURVEYOR required for inspection of Boiler and Pressure plant. Must have 1st Class M.O.T. Certificate with Steam endorsement or equivalent. Starting salary £800, rises to £1100 (E.S.A. Scale). Other benefits. Area Chester and North Wales.—Apply Eng. Dept., General Assurance Corp. Ltd., 99, Aldwych, W.C.2. E5601 A

LIFT ENGINEER required by Insurance Company for inspection of lifts. Must have served apprenticeship with lift construction firm, and hold at least O.N.C. or equivalent in Electrical or Mechanical engineering. London. Starting salary £800 p.a., pension, widows' pension, &c.—Write with full details to Box ER728, LPE, Romano House, 399-401, Strand London, W.C.2. E5620 A

SITUATIONS VACANT

ESTIMATOR for Fabrication, Plate Work, Pressure Vessels, Welded Structures, etc., required for East Anglia. State experience and salary required. BOX No. E2958, " The Engineer." A

EUCLID (GREAT BRITAIN) LIMITED
have a vacancy for a
TECHNICAL ARTIST

Experience in technical illustration essential ; experience in lay-out, lettering and re-touching desirable. The job entails design and art work of technical literature sales folders, and advertisements.

The Company operates a comprehensive personnel policy including Free Life Assurance and Contributory Pension Scheme. Canteen facilities on the Estate.—All applications in writing to the Personnel Department, Euclid (Gt. Britain) Limited, Newhouse Industrial Estate, Motherwell.

E5629 A

FORD MOTOR COMPANY LIMITED
ENGINEERING RESEARCH
LODGE ROAD
BIRMINGHAM 19

have vacancies for TWO SENIOR DEVELOPMENT ENGINEERS in their Power Units Engineering Research Department, to work on the Development of Advanced Projects.

Applicants should be corporate members of the Institution of Mechanical Engineers ; a degree in Mechanical Engineering would be an advantage.

They must be fully capable of taking complete charge of Projects involving Design, Research and Development of all forms of internal combustion engines with experience preferably in those for Passenger and Commercial Vehicles.

Age range 30-40 years. These are positions of responsibility and carry an appropriate salary in accordance with qualification and experience.

E5636 A

G.W.B. FURNACES LIMITED
Control Gear Division

SALES ENGINEER

required for London and the Home Counties.

He should have experience of electric motor control gear, contactors, relays, multi-motor control panels, switchboards, etc.

This is a senior appointment and a good salary is paid, plus expenses. The position is permanent and pensionable.

A company car is provided.

Write in confidence, giving details of age, qualifications and career to date, to :

Sales Manager,
Control Gear Division,
G.W.B. Furnaces Limited,
Dudley, Worcs.

E2964 A

LAPORTE CHEMICALS LIMITED
WARRINGTON

require an INSTRUMENT ENGINEER to take complete responsibility for their progressive Instrument Department. Age between 26-45 years. Minimum qualifications—H.N.C. Applicants should have a thorough knowledge of modern pneumatic and electronic instruments and experience in the maintenance of automatic control equipment in heavy chemical or petroleum processes. A good salary will be paid commensurate with age and experience. A Pension Scheme is in operation, and, in selected cases, assistance can be given towards removal expenses and house purchase.

Replies, giving details of age, qualifications and experience, and quoting ref LCW/TE1/58 should be addressed to the Group Personnel Manager, LAPORTE INDUSTRIES LIMITED, Hanover House, 14 Hanover Square, London, W.1.

E5624 A

MIDLAND SILICONES LTD.

(A Company of the Albright & Wilson Group) require a

PROJECT ENGINEER

in the Engineering Department at Barry. He will be responsible to the Senior Project Engineer for the Mechanical Design of the new chemical plant. He will co-ordinate the work of other departments concerned with new projects. He will also be responsible for procurement and the control through the erection engineer to project completion.

Qualifications required are H.N.C. in Chemical Engineering. It is essential that several years experience is possessed in the design and construction of chemical plant. It is likely that this experience would have been largely obtained in a drawing office. Aged 30-35. Midland Silicones, Ltd., is a rapidly growing company in a new field of chemical products. The Works are situated in a pleasant locality.

Good commencing salary. Assistance with housing is available. Good prospects.

Apply : Staff Officer,
Group Personnel Department,
Albright and Wilson Ltd.,
1 Knightsbridge Green, London, S.W.1.
Ref. 11.

E5572 A

SITUATIONS VACANT

GIRL capable of tracing work (typing an advantage but not essential) required by a City Insurance Firm. Salary according to ability. Luncheon vouchers. 5 day week. Permanent progressive post. BOX No. E5530, " The Engineer." A

MECHANICAL ENGINEER

Burma Corporation (1951) Limited, a large Mining Company operating in Upper Burma, climate sub-tropical and healthy, has a vacancy for a Mechanical Engineer. Applicants must be suitably qualified and have had not less than 5 years practical experience (excluding apprenticeship) in all round mechanical engineering in a heavy industry.

Four years agreement ; six months paid leave of which three months normally permitted after two years : contributory Provident Fund, free passage, partly furnished quarters and medical attention. Commencing salary and allowances aggregate K.1,325 (£99 7s. 6d.) per month, rising to K.1,475 (£110 12s. 6d.) in fourth year. Advise fullest details education, qualifications, experience, age and family status.

Write Box T.637, W.P.S., 4 Holborn Circus, London, E.C.1.

E5634 A

PILKINGTON BROTHERS LIMITED, Cowley Hill Works, invite applications from ELECTRICAL DESIGN ENGINEERS to take charge of a small Electrical Drawing Office, and be responsible to the Works Electrical Engineer for H.V. and M.V. Distribution Schemes, including lighting circuits and a certain amount of D.C. work, in all amounting to a maximum demand of 15 M.V.A. He will also be responsible for estimates and ordering of materials. Five-day week, superannuation scheme, assistance with house purchase.—Applicants who should have H.N.C. and, preferably, Graduate Membership of the I.E.E. should write to the Works Personnel Officer, Cowley Hill Works, Pilkington Brothers Limited, St. Helens, giving details of age and experience. E5599 A

PROCESS ENGINEERING

CALTEX SERVICES LIMITED

require

CHEMICAL ENGINEERS

for their London Office, with the possibility of overseas service with their Associates in the Middle East or elsewhere.

Applicants, preferably Honours Graduates, under 28 years of age, should have either recently qualified or have had a minimum of two years process engineering experience. The work is connected with processing studies, refinery technical services and some process design as encountered in the petroleum industry.

The commencing salary would be dependent upon qualifications and experience, and for Foreign Service additional allowances are paid together with certain other advantages.

Apply in writing, quoting " ETS/LN " with full particulars of qualifications and experience to :

Manager-Personnel,
Caltex Services Limited,
Caltex House,
Knightsbridge Green,
London, S.W.1.

E5616 A

PRODUCTION CONTROL. Experienced ENGINEER required for control of Estimating, Buying and Progressing and expanding engineering company. Applications should give details of engineering and administrative experience and salary required.—BOX No. E2970, " The Engineer." A

RESIDENT ENGINEER required to supervise construction of a 20,000-ton silo at Hull. Previous experience essential. The work is about to start.—Please write giving details of experience and salary, and when able to commence to L. G. Mouchel & Partners, Southbank House, Albert Embankment, London, S.E.11.

E5633 A

TECHNICAL AUTHOR required, not over 45, to assume responsibility for the compilation of operating and maintenance instruction manuals dealing with the Company's machinery. This interesting and progressive pensionable staff position would appeal to a suitably qualified Mechanical Engineer with a bias towards technical writing.—Applications should be addressed to the Personnel Manager, Molins Machine Co. Ltd., Evelyn Street, London, S.E.8.

E5590 A

SCOTTISH AGRICULTURAL INDUSTRIES LIMITED have a vacancy for an experienced WORK STUDY OFFICER with engineering qualifications. Candidates should be between 25 and 35 years of age and should have had not less than 2 years experience in Work Study and the application of Incentive Schemes based on Work Study. The post is permanent and pensionable and the starting salary offered will be related to age, qualifications and experience.—Application forms will be forwarded to suitable candidates on receipt of brief details of age, qualifications and experience addressed to the Personnel Officer, Scottish Agricultural Industries Limited, 39 Palmerston Place, Edinburgh, 12. Tel. No. CAL 2581, quoting Ref. No. 25. E5600 A

Classified Advts. continued on page 98

SITUATIONS VACANT

THE REED PAPER GROUP

requires an

INSTRUMENT PROJECT ENGINEER

Applicants, aged under 45 years, should have H.N.C. as a minimum qualification and previous experience in a responsible position connected with Process Instrumentation is essential.

Applicants should be capable of selecting suitable equipment and of organising and approving installations.

Commencing salary will be by arrangement with the successful applicant.

Conditions of service include non-contributory superannuation scheme and assistance with house purchase, if required.

Written applications, with full details of career to date should be addressed to :
The Group Personnel Officer,
Albert E. Reed & Co. Ltd.,
Larkfield, Nr. Maidstone, Kent,

quoting reference IPE/GE/67.

E5637 A

WANTED : CHARTERED MECHANICAL ENGINEER for work in Company Head Office in London. Required to assist in development, preparations of drawings, specifications, erection and commissioning of plant at various factories in this country. Write giving details age, salary required and experience to BOX No. E5594, " The Engineer." A

WORKS MANAGER required for Agricultural Engineering Works in East Anglia. Must have knowledge of Batch Production of Machines and Management of Men. Staff now about 40. Housing accomodation available. Salary according to qualifications and experience.—Reply in confidence giving Age, Qualifications and Experience to BOX No. E5467, "The Engineer." A

YOUNG ENGINEER required, minimum qualifications H.N.C. in mechanical engineering and some drawing office experience, to develop and control new production where engineering training is of major importance. This job offers interest, opportunity, and excellent future prospects to an ambitious, conscientious and intelligent young engineer.—BOX No. E2965, " The Engineer." A

SITUATIONS VACANT

CHIEF ENGINEER

Required for large non-ferrous foundry in Midlands. Must have experience of all types pneumatic, hydraulic and electric equipment. Capable of organising for preventive maintenance.

Please write in confidence giving full details to :

Managing Director,
BIRMID INDUSTRIES LIMITED,
Dartmouth Road,
Smethwick, 40, Staffs.

E2966 A

DRAUGHTSMEN

Draughtsmen are required at the Midlands Research Station, Solihull.

The duties are interesting and will include work on the design of pilot and prototype plant associated with the development of new high-pressure processes for the production of town gas.

Candidates should possess at least an O.N.C. certificate in Mechanical Engineering.

The salary for the appointments, which are pensionable and subject to medical examination will be within the range of £770-£1015 per annum.

Applications, stating age, education and experience, should be addressed to the Industrial Relations Officer,

WEST MIDLANDS GAS BOARD,
6, Augustus Road, Edgbaston, Birmingham, 15

E190 A

SITUATIONS VACANT

DESIGN DRAUGHTSMAN

Thomas Morson & Son Ltd., require a design draughtsman for work on chemical plant design, layouts, piping work etc., Candidates who should have a H.N.C. in mechanical engineering or equivalent will be expected to deal with a wide variety of the problems met in project engineering. Salary not less than £1000 p.a. depending on experience and qualifications.

Apply Engineering Director, Thomas Morson & Son Ltd., Wharf Road, Ponders End, Enfield, Middlesex.

E2972 A

SITUATIONS VACANT

Project Engineer

(INDIA)

PROJECT ENGINEER required by well known British Company of Engineering Contractors engaged on the building of heavy engineering plant. Applicants must have civil and/or mechanical engineering qualifications and experience of site construction is desirable. Preference will be given to applicants aged 25/40 who are qualified civil engineers with experience of plant erection. If required married accommodation will be available in Calcutta but the successful applicant must be prepared to travel to any contract in India. Good salary and bonus will be paid. Pension scheme is in operation. Tour of duty will be for three years initally with liberal leave. Send full details of training, qualifications and experience in strictest confidence to BOX No. E5587, " The Engineer." A

FAWCETT PRESTON & COMPANY LIMITED

A member of the Metal Industries Group

invite applications for the following appointments:—

SENIOR HYDRAULIC DESIGN ENGINEER to take charge of the Hydraulic Development Department. Preference will be given to applicants possessing a degree or other suitable qualifications, but the essential requirement is for an Engineer with initiative and who has previous experience in Press design.

PLASTICS TECHNICIAN to work in conjunction with Engineers and Sales Staff on the development of machinery for the Plastics Industry. Preference will again be given to candidates with a degree or other suitable qualifications and practical experience in the design and operation of Extruder production.

MECHANICAL ENGINEER to act as Section Leader in the Production Drawing Office. Preference will be given to candidates with a degree or other suitable qualifications and previous experience in the design and operation of Extrusion equipment is desirable.

DESIGN ENGINEERS for the Plastics and Rubber Extruder Development Department. Preference will be given to candidates with an H.N.C. or equivalent qualification and with previous experience of this equipment.

DESIGN AND DETAILING DRAUGHTSMAN with previous experience in Hydraulic or Plastic machinery, although applicants with a good mechanical engineering background will be considered.

ENGINEERING ESTIMATORS preferably with experience of Hydraulic Presses and/or Rubber and Plastics machinery, and/or Sheet Metal work.

Salaries for these appointments will be commensurate with the experience and qualifications of the successful candidates, and good prospects of promotion exist. The Company operates a Contributory Pension Scheme, together with Life Assurance and other benefits.

Applications in confidence stating age, education, qualifications and experience should be sent to the Secretary, Fawcett Preston & Company Limited, Dock Road, Bromborough, Cheshire.

E5630 A

Some engineers

lose flexibility as they gain experience ; they learn a technique, whether with drainage or with dynamometers, and cannot apply themselves to anything else.

The engineering problems imposed by the extreme conditions of modern chemical processes cannot be solved by traditional rules of thumb: they require original thought based on fundamental engineering principles.

If you have acquired practical competence and a balanced outlook, and are still prepared to enter fresh fields of thought: if you are about 30, with a good degree, preferably in mechanical or electrical engineering: if you want a job that has variety, and wide opportunities in engineering and management : if you would like to work on a modern industrial site and live in pleasant country surroundings: you should get in touch with

THE STAFF MANAGER,
IMPERIAL CHEMICAL INDUSTRIES LIMITED,
WILTON WORKS,
MIDDLESBROUGH,
YORKSHIRE,

quoting reference RB/3.

E5608 A

The following

PHYSICISTS

are required for a test team to operate the British Nuclear Prototype Propulsion Machinery, situated at Dounreay, Caithness, Scotland :

ONE HEALTH AND SAFETY PHYSICIST
ONE SENIOR HEALTH PHYSICIST
ONE JUNIOR HEALTH PHYSICIST

The first two are senior appointments and applicants should have had previous experience in the field of Health Physics. In the case of the Health and Safety Physicist, practical experience in the operation of reactors is a requirement.

The Company operates a contributory pension fund and applications giving full details should be sent to :

The Manager, Marine Propulsion,
Research and Development Dept.,
VICKERS-ARMSTRONGS (ENGINEERS) LIMITED,
Naval Construction Works, Barrow-in-Furness, Lancs.

E5612 A

JOHN BROWN AND COMPANY LIMITED

Engineers and Shipbuilders

INCREASED PROFITS AND STRONG LIQUID POSITION

LORD ABERCONWAY'S STATEMENT

THE ninety-sixth Annual General Meeting of John Brown and Company Limited will be held on September 2 in London.

The following is an extract from Lord Aberconway's statement circulated with the Report and Acounts for the year ended March 31, 1960:

The Consolidated Profit before tax was (to the nearest £1,000) £3,645,000, an increase of £292,000 over that of the previous year. The Consoliadted Balance Sheet reveals a strong liquid position. Cash and its near equivalent stand at £8,810,000, an increase over the previous year of £3,651,000. In view of the increase in profit, and of the strong liquid position, the Directors have decided to recommend a final Ordinary dividend of 7 per cent, less tax, making a total for the year of 11 per cent, less tax, compared with 10 per cent, less tax, for the previous year.

Sir Stanley Rawson, to the great personal regret of his colleagues, retired during the year from the Board. His knowledge and experience, and his wisdom and judgment, will be much missed.

Shipbuilding

Her Majesty the Queen Mother graciously visited Clydebank on September 16, 1959, to name and launch the 50,000 ton deadweight tanker s.s. "BRITISH QUEEN" for the B.P. Tanker Company Ltd. Earlier in the year the same owners took delivery of a 42,000 ton tanker s.s. "BRITISH JUDGE," and m.v. "CLAN MACINDOE" was completed for the Neptune Shipping Company Ltd. The anti-submarine frigate H.M.S. "YARMOUTH" was commissioned in March, 1960, and earned high praise from all who inspected her.

Two 50,000 ton deadweight tankers are under construction and the s.s. "TRANSVAAL CASTLE" of 33,000 ton gross will be launched next January for The Union-Castle Mail Steamship Company Ltd. Good progress is being made on H.M.S. "HAMPSHIRE," a guided missile ship.

Clydebank has co-operated over a considerable period with The Cunard Steam-Ship Company Ltd. in their design studies for a new express liner, and it is gratifying that the Chandos Committee has approved the resulting design. It is, of course, our hope that Clydebank will be asked to extend its collaboration to the building of the ship.

On September 30, 1959, Sir James McNeill relinquished his executive duties as Managing Director of John Brown & Co. (Clydebank) Ltd. He remains as Deputy Chairman of the Clydebank company, where his experience, his judgment, and his incomparable knowledge of shipbuilding will be of inestimable value, and continues, of course, as a director of John Brown & Company. He is succeeded, as Managing Director of the Clydebank company, by Mr. John Brown, formerly the Naval Architect.

Land Boilers

The business of supplying large boilers for power stations, in which **John Brown Land Boilers Ltd.** is engaged, has continued to be difficult. The orders remaining to be executed will shortly be very few. Indeed, the order for a boiler for Bankside station remains the only order that the company has received from a British generating authority for more than four years. The recently announced addition to the programme of new generating capacity is helpful; even so, the future of John Brown Land Boilers Ltd. is far from assured.

Machine Tools and Engineers' Tools

Wickman Ltd. during the latter half of the year experienced a very substantial increase in the demand for its multi-spindle automatics. Most of this came from makers of motor vehicles and domestic appliances, at home and overseas. More orders were received last year for automatics than ever before, and quoted deliveries, which had been reduced to some six months, are now about eighteen months. Wickman's manufacture and sales of "Wimet" tungsten carbide tools have increased considerably, and re-tooling of automatics with "Wimet" tools is becoming an increasing feature of its business.

Webster & Bennett Ltd. continued in full production during the year and achieved a record output of its vertical boring and turning mills. The rate of incoming orders has improved since this time last year, but is still much below the capacity of the factory. A moderate reduction in the production programme will therefore be necessary in the latter part of the current year; but owing to labour wastage this will involve no redundancy.

Firth Brown Tools Ltd. has benefited from the general revival in the demand for engineers' cutting tools, and has had a good year both at home and in export markets. A new research department on machinability is nearing completion; an important unit in this is a new test lathe with exceptional speed and power, with which it is intended to explore the next generation of machine tools designed to exploit more fully the potential of carbide and ceramic tools.

Other U.K. Interests

S. N. Bridges & Co. Ltd. continues to experience intensely competitive conditions; nevertheless, sales of the industrial range of portable electric tools increased; and more orders from overseas were obtained. The first stage of the rebuilding and modernisation of the newly-acquired works in York Road, Battersea, completed during the year, enables a higher output and a greater efficiency to be achieved, and plans are well advanced to launch new products.

Since the end of the financial year, the order previously given to **Cravens Ltd.** by London Transport Executive for 248 cars for the Amersham service has been increased by a further quantity of 216 cars for the Uxbridge service. Deliveries have begun of ten prototype underground cars, which incorporate interesting and original features, both in design and finish. During the year Cravens completed the Ship Tank Carriage for the Ship Hydrodynamics Laboratory (National Physical Laboratory), Feltham; this was a fine piece of mechanical engineering and construction. Sale of plastic injection moulding machines to the designs of Hydraulic Press Manufacturing Co. increased considerably during the year.

For **Markham & Co.** the difficult trading conditions reported last year continued during the first half of the year. Latterly, however, there was a better demand for its medium and heavy engineering products, and orders from the National Coal Board for several winding engines have been obtained. There is intense world competition in the water turbine field where Markham's manufacture for Boving's.

John Brown (S.E.N.D.) Ltd. serves as a sales, design, and contracting organisation for special projects, and as a means of deploying, in executing such projects, the manufacturing resources of the appropriate subsidiaries of the Company. An arrangement has been made with Demag A.G., the well-known German engineering firm, and a substantial order for rolling mill equipment has already resulted.

The Company, jointly with Solartron Electronic Group Ltd., has formed a new company, Solartron-John Brown Automation Ltd., to enter the potentially large field of completely automatic dispensing for warehousing and supermarket operation. The Company has acquired a substantial interest in Auto-Stackers Ltd., which is constructing at Woolwich, this country's first automatic mechanical multi-storey garage. Sir Norman Hulbert has been appointed Chairman of both Solartron-John Brown Automation Ltd. and Auto-Stackers Ltd.

Constructors John Brown Ltd. was successful in securing a number of contracts for chemical plants and oil installations in the United Kingdom during the year, despite the general recession in capital projects in 1959, which has made competition keener. Latterly inquiries in this country have been scarcer, but work of the sort in which C.J.B. is interested is being offered in fair volume overseas. Much of it, however, requires credit, and many foreign competitors seem able to offer longer terms than those which British contractors can arrange, or for which insurance cover can be obtained.

Overseas Interests

The Company's overseas businesses increase continually in number and importance. In Canada, despite intense competition and other difficulties facing secondary manufacturing industries, the Company's three subsidiaries hold their positions and render important service to Canadian industry. **Firth Brown Steels Ltd.**, in its extensive warehouses in Montreal and Toronto, handles stainless and heat-resisting steels in many forms. **Firth Brown Tools (Canada) Ltd.** manufactures a range of engineers' cutting tools in its plant at Galt, and imports others from its parent company in Sheffield. **A. C. Wickman Ltd.** in Toronto holds a wide range of agencies for machine tools and other equipment and manufactures tungsten carbide tools and mining drills. In Africa, the conduct of business brings many anxieties, but the Board has confidence and believes that the Company's various organisations will continue to contribute industrially to the stability and increasing prosperity of these countries. **Wickman (South Africa) Ltd.** makes tungsten carbide rock drills and other tools. **Firth Brown Tools (Pty.) Ltd.** supplies Speedicut tools throughout the Union and Rhodesia, and has stocks and technical services available in several centres. F. Issels & Son Ltd. (in which the Company has a half share) in Bulawayo, in spite of heavy competition, has secured and completed important engineering work and has further developed its iron and steel foundries. Rhodesian Alloys (Pvt.) Ltd., in which the Company has a substantial stake, has operated to full capacity supplying to many world markets high quality low carbon ferro-chrome, an essential component of stainless steels. In Brazil, Wickman has taken a majority interest in an established company, Brasmac. A factory has been built in San Paulo, in which sparking plugs for Champion International are being produced, various components for the automobile industry are being made, and manufacture of tungsten carbide tools will shortly start. The rest of the business of this firm is in importing machine tools. **Machine Tools (India) Ltd.** has continued to render an important service to the developing community, in the supply of machine tools to India, as agents of principals all over the world. A technical aid agreement has been made whereby Wickman will help an Indian company to produce tungsten carbide products, which Machine Tools (India) will sell. In Australia, **Wickman (Australia) Ltd.** continues, as importers and distributors of machine tools, to serve Australian industry and to increase its turnover; it also sells tungsten carbide tools manufactured in Australia at successive stages by associated companies. In the United States, Wickman is building a sales organisation to handle the distribution, through appropriate agents in various parts of the country, of machine tools made by the Company's subsidiaries and by others whose U.S.A. agency Wickman holds.

Westland Aircraft Ltd.

Westland Aircraft Ltd., in which the Company has a substantial shareholding, has emerged from the recent reorganisation of the aircraft industry as one of the principal groups after buying Saunders-Roe Ltd., the Helicopter Division of Bristol Aeroplane Co. Ltd. and Fairey Aviation Ltd.

General

Stockholders can be assured that new lines of activity are constantly being looked into and developed, either by way of extensions to the existing activities of subsidiaries, or by way of the acquisition of existing businesses, or by way of joining wth suitable partners to found new enterprises. In this way the basis of the Company's activities is broadened, and the businesses of the existing subsidiaries, many of which face uncertainties and difficulties, are strengthened. Indeed, many of these new enterprises are deliberately chosen so that when they develop they may well provide work for, or otherwise fit in with, one or more of the Company's established subsidiaries.

It is remarkable how the ups and downs of the various businesses that comprise the Company's interests have, in recent years, offset each other, so that profits have steadily increased, a firmer base has been provided, and a financial strength has been built up that enables the Company both to continue its progress and to face with confidence whatever difficulties arise.

For this satisfactory state of affairs, and for the successful results of a year which, in many of the Company's businesses, has been far from easy, the efforts of the managements, the staffs and the workpeople of the subsidiary companies are largely responsible. To all of these the best thanks of the Stockholders and the Directors are due.

Classified Advts. continued on page 100

SITUATIONS VACANT

MANAGER

Manager, preferably 35-45, with engineering training and holding degree or professional qualification in either Mechanical or Production Engineering. Previous experience in control of a light or medium engineering manufacturing unit consisting of machine shop and foundry would be an advantage.

This appointment is offered by a large engineering Group with early opportunity for advancement to the right person. First Class Contributory Pension Scheme.

State (in confidence) age, education, technical training, experience and present salary. Present employers will not be approached without applicant's permission. BOX No. E5628, " The Engineer " A

DUBAI ELECTRICITY COMPANY
TRUCIAL STATES
PERSIAN GULF

APPOINTMENT OF CHIEF ENGINEER AND MANAGER

Applications are invited by the Dubai Electricity Company, Trucial States, for the position of Chief Engineer and Manager. Candidates should be qualified in Electrical Engineering and hold Membership of at least one of the Corporate Institutions, together with managerial and administrative experience. Commencing salary Rs 2,500 per month tax free and free furnished accommodation. Tours would be of two years' duration followed by three months' home leave. Air passages provided for wife and up to two children once in each contract period.

Applications, stating date of birth, qualifications and experience, together with names of three Referees, should be addressed to Reference R.F.S., Kennedy & Donkin, 12 Caxton Street, London, S.W.1., to arrive not later than September 16th, 1960.

E5606 A

Reed

REED CORRUGATED CASES LTD.
have a vacancy for a

WORKS ENGINEER

at their Wigan Branch

Applications are invited from Mechanical Engineers, aged 28-40, with a recognised engineering apprenticeship and qualifications at least to H.N.C. level.

The successful applicant will be responsible to the Works Manager for the maintenance of a wide variety of plant and preference will be given to those having first hand knowledge of Planned Maintenance schemes. A number of years experience in a similar capacity is essential

Excellent conditions of service are offered, including a non-contributory pension Scheme.

Please write giving full details of experience, qualifications, present post and salary to the

Personnel Manager,
Reed Corrugated Cases Limited,
Reed House, New Bridge,
Brentford, Middlesex,
quoting *reference WE/W.* E5622 A

WORK STUDY ENGINEERS

are invited to apply for vacancies that offer temporary engagements, at advantageous terms of 1 to 2 years duration, in a light Engineering factory situated in the Midlands.

The project involved is of importance and concerns review, re-study and implementation of Company Policy in the application of Work Study affecting several thousand employees.

Permanent posts will be available to some participants on completion of this project.

Applicants should write, quoting EG/M, stating age, qualifications and experience to The Personnel Manager, BOX No. E5593, " The Engineer." A

SITUATIONS VACANT

APPLEBY-FRODINGHAM STEEL COMPANY

SCUNTHORPE - LINCOLNSHIRE

invite applications for

SENIOR DESIGNER

also

SENIOR and JUNIOR DRAUGHTSMEN

for general engineering work.

Experience with plant for Iron and Steelworks would be an advantage but is not essential.

Permanent situations with good prospects of advancement for men with initiative and ability.

Staff Pension Scheme, welfare and sports facilities are available.

Apply, giving age, full particulars of previous experience and technical qualifications to the Chief Engineer. E5491 A

SITUATIONS WANTED

ENGINEER, age 30. Experienced supervision site erection, negotiations with clients, &c., overseas, time served, O.N.C., D.O. experience. Seeks position admin., erection engineer, technical representative, &c. Resident N.W. London area.—BOX No. E2973, " The Engineer." B

YOUNG ENGINEER, Honours Degree, indentured apprenticeship and design experience, desiring outdoor life, seeks Technical Representative appointment with progressive firm, preferably in East Anglia.—BOX No. E2971, " The Engineer." B

BUSINESS OPPORTUNITIES

A BARGAIN. £25 complete. BRAND NEW READY-MADE CO. REGNS. Guaranteed no trading (ENGLAND OR SCOTLAND)—all trades available NOW including Engineering ; Electrical Engineering ; Motor Engineering ; Garage ; Machinery ; Metal ; Haulage ; Hire Purchase ; Investment ; Property (specially prepared for each trade).—BUSINESS ECONOMY CO. REGNS., LTD., Dept. T/16, 156, Strand, London, W.C.2. (Tem. 8377/2294), for English companies, and to 19, Walker Street, Edinburgh, 3 (Cal. 1167/8/9), for Scottish Companies. Read " ADVANTAGES OF TRADING AS A LIMITED COMPANY " (3s. post free) ; Limited Co. may save you tax. We have seven-day Co. Regn. service with your own choice of name. £21 complete, plus stamp duties. E182 O

MISCELLANEOUS

DEVON AND CORNWALL. Accommodation booked anywhere at immediate notice from 7 gns., plus 2 gns. booking fee.—Write or 'phone Carol Robinson Bureau, Morley Street, Plymouth. Telephone No.: Plymouth 62646. E5552 I

TIME RECORDERS, Sales, Rentals, Service, Telephone Hop 2239.—Time Recorder Supply and Maintenance Co., Ltd., 157-159, Borough High Street, London, S.E.1. E110 I

BUSINESSES and PREMISES

GATESHEAD

Modern factory.

Approximately 21,000 square feet.

All modern services.

Internal height 20 feet.

Prominent position.

Details :
KNIGHT, FRANK & RUTLEY,

20 Hanover Square, W.1.

Telephone : MAY 3771.

E5638 L

PATENTS

THE PROPRIETOR of British Patent No. 728549, entitled " IMPROVEMENTS IN, AND RELATING TO, INTERNAL COMBUSTION ENGINES," offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern & Carlberg, 140 S. Dearborn Street, Chicago 3, Illinois, U.S.A. E5631 H

THE PROPRIETORS of Patent No. 778173 for " IMPROVEMENTS IN, OR RELATING TO, DISPENSING APPARATUS FOR LIQUID FUEL," desire to secure commercial exploitation by Licence or otherwise.—Replies to Haseltine, Lake & Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2. E5558 H

SUB-CONTRACTING

KELLERING AND CAM PROFILING capacity up to 8ft by 6ft or 6ft diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

SUB-CONTRACTING

MOBILE LIFTING SERVICE. Lump Sum or Hire Rate quoted for any lifting work by Lorry-Mounted or Crawler Cranes, any size, any area.—TARSLAG, LTD., Rotherham 78481. E187 MW

MACHINERY Etc. WANTED

HORIZONTAL BORING MACHINE with 4in. spindle ; must be modern.—BOX No. E5603, " The Engineer." F

REQUIRED URGENTLY—Secondhand 2 and 3 cubic yard Whole Tine Grabs, or similar, for Rock dredging.—Details and price, write Box E737, L.P.E., Romano House, 399-401, Strand, London, W.C.2. E5635 F

FOR SALE

FRED WATKINS (ENGINEERING) LTD.

STEAM BOILERS.—Cochran Vertical (New) 7ft. and 6ft. 6in. dia., 150 lb. w.p.; reconditioned 9ft. down to 3ft. dia.; Economic 4ft. to 11ft. 6in. dia., including new 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstubes, all sizes.
AIR COMPRESSORS.—Two Belliss & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors ; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised ; and several others of various makes and capacities.
200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 200 h.p .
MOBILE ROAD CRANES.—10-ton Lorain lorry-mounted 30ft.-70ft. extendible jib ; 8½-ton Ransome Diesel/Electric 21ft. jib ; 6-ton Coles Diesel/Electric, solids ; 4-ton Soles Diesel/Electric, solids, 1945 ; 4-ton Jones KL44, diesel, 1950 ; 3-ton Jones " Super 40 " diesel, pneumatics (3).
OVERHEAD CRANES.—25-ton Girders and end carriages, with 60 h.p. motors, 95ft. 10in. span ; 30-ton Vaughan, 42ft. 3in. span ; 25-ton Clyde, 21ft. 9in. span, new 1954 ; 20-ton Vaughan, 42ft. 3in. span, 6-ton auxilliary, cab control (5) ; 20-ton King, 42ft. 3in. span, 400/3/50 ; Wharton, 7½-ton, 25ft. span, 400/3/50 ; 5-ton Henderson, 24ft. 7in. span, 1946 ; 5-ton Morris, 58ft. span, hand-operated ; 5-ton King, 29ft. 3in. span, power hoist, hand travel ; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel ; 4-ton Morris, 19ft. span, 220V. d.c. (3) ; majority of the above are unused.
DERRICK CRANES.—7-ton Anderson Grice, 100ft. jib, electric ; 7-ton Rushworth hand, 30ft. jib ; 1½-ton Anderson Grice, hand, 40ft. jib ; 5-ton Butters Grabbing, 80ft. jib, electric.
RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jib ; 10-ton Grafton, 34ft jib., diesel conversion ; 8-ton Wilson, steam, 35ft. jib ; 5-ton Smith, 50ft. jib (2).
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September 1	**Vehicles, machine tools and miscellaneous stores.**	**M.O.A. Storage Depot, Bowhouse, Hurlford, Nr. Kilmarnock, Ayrshire.**	**DIXON & WALLACE, LTD.** (Dept. L), Bank Buildings, Graham Square, Glasgow, E.1. (Tel.: Bridgeton 2447/9.)
September 6-7	**Machine tools and miscellaneous stores.**	**M.O.A. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18.**	**FULLER, HORSEY, SONS & CASSELL** (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel.: Royal 4861.)
September 13	**Miscellaneous stores.**	**No. 1 E.S.D., Long Marston, Nr. Stratford-on-Avon, Warwicks.** (Sale at the Hippodrome, Stratford-on-Avon.)	**LOCKE & ENGLAND** (Dept. L), 166, Parade, Leamington Spa, Warwicks. (Tel.: 2833.)
September 16	**Miscellaneous stores.**	**M.O.A. Storage Depot, Rotherwas, Hereford.**	**RUSSELL, BALDWIN & BRIGHT, LTD.** (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)
September 21	**Machine tools and miscellaneous stores.**	**Technical Stores Depot, Old Dalby, Leics.** (Sale at Melton Mowbray.)	**SHOULER & SON** (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel.: 3081.)
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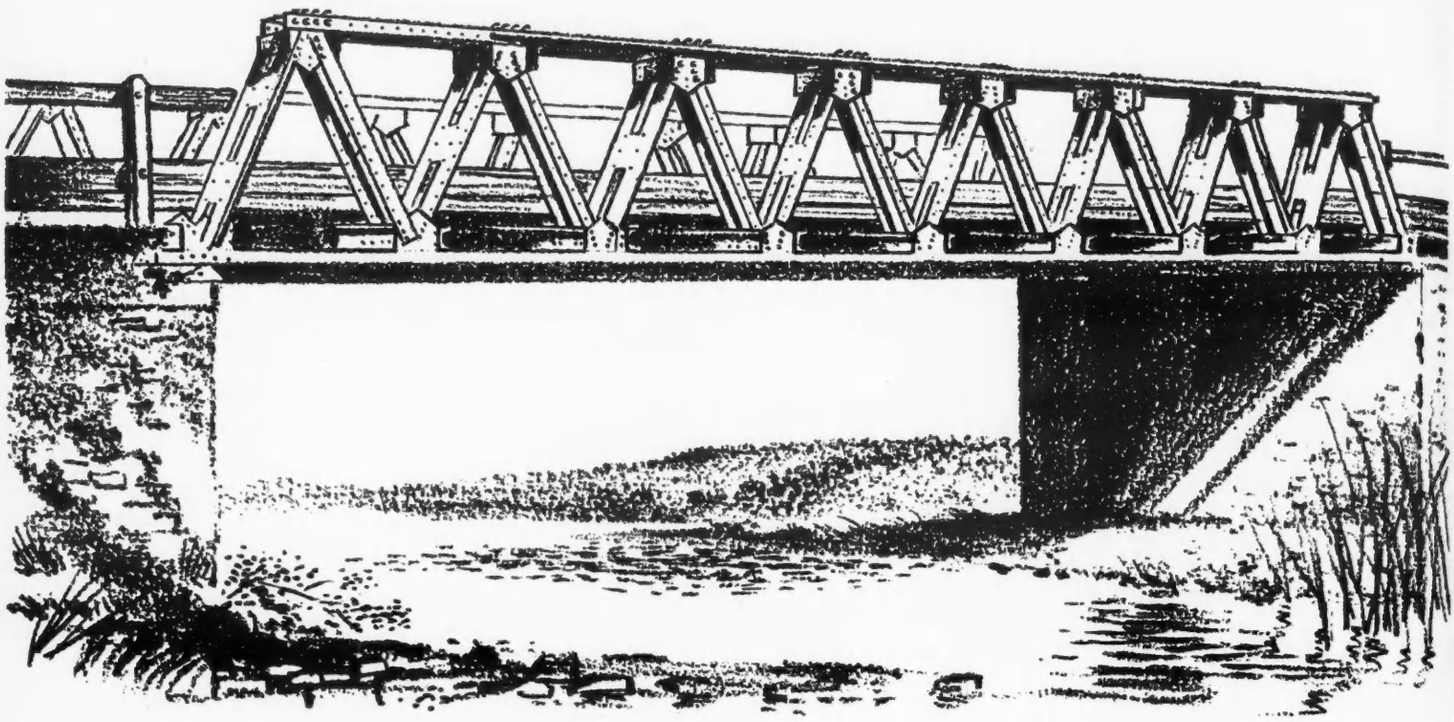

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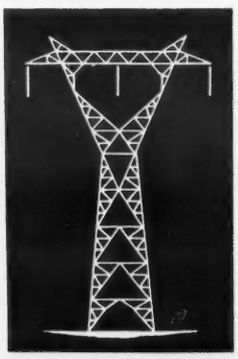

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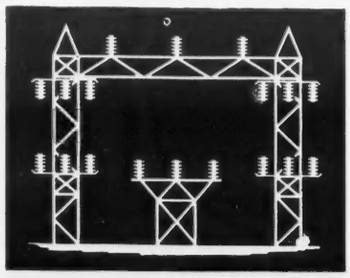

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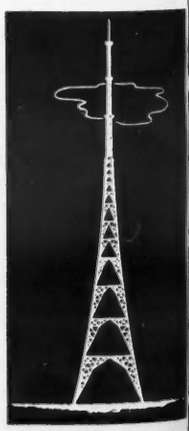

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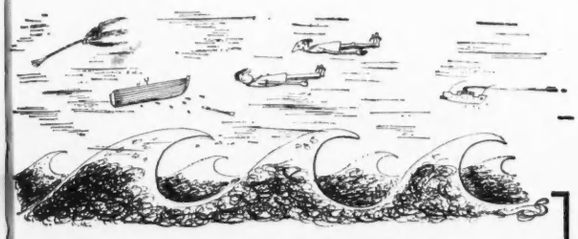

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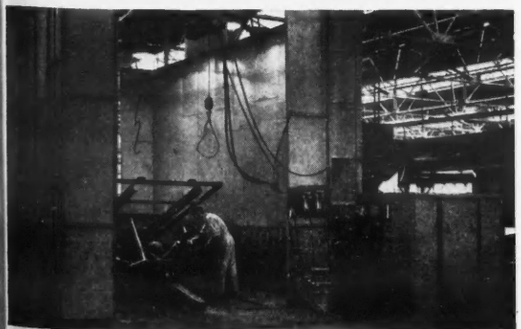

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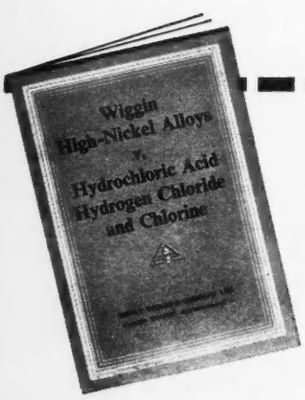

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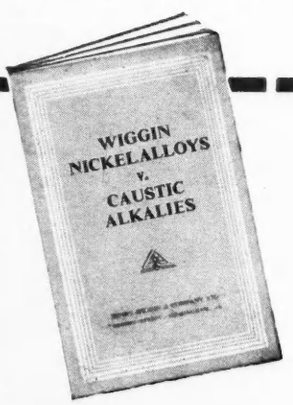

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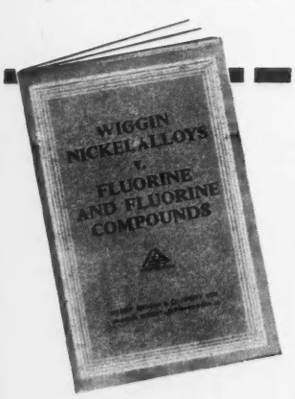

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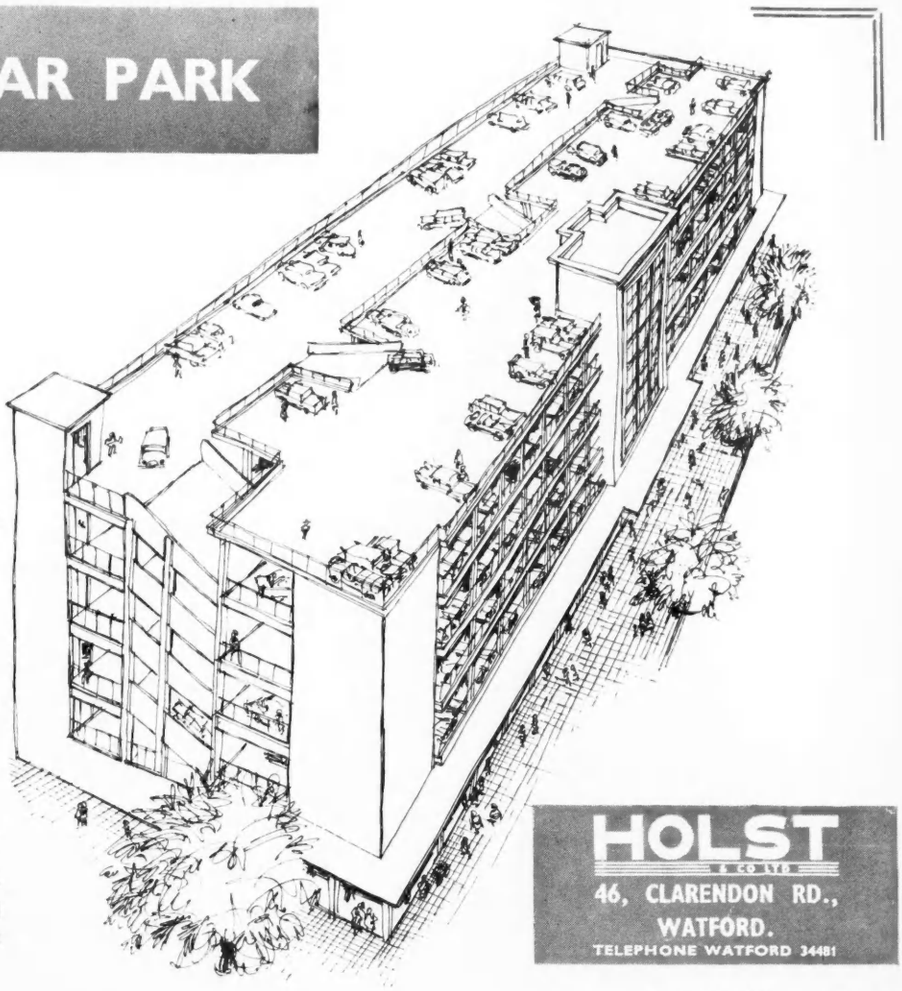

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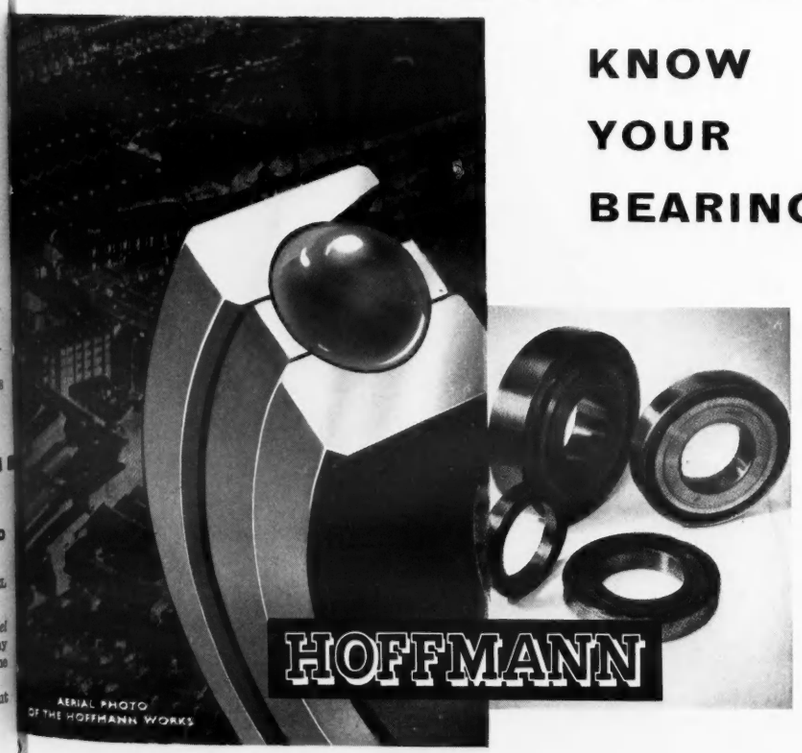

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